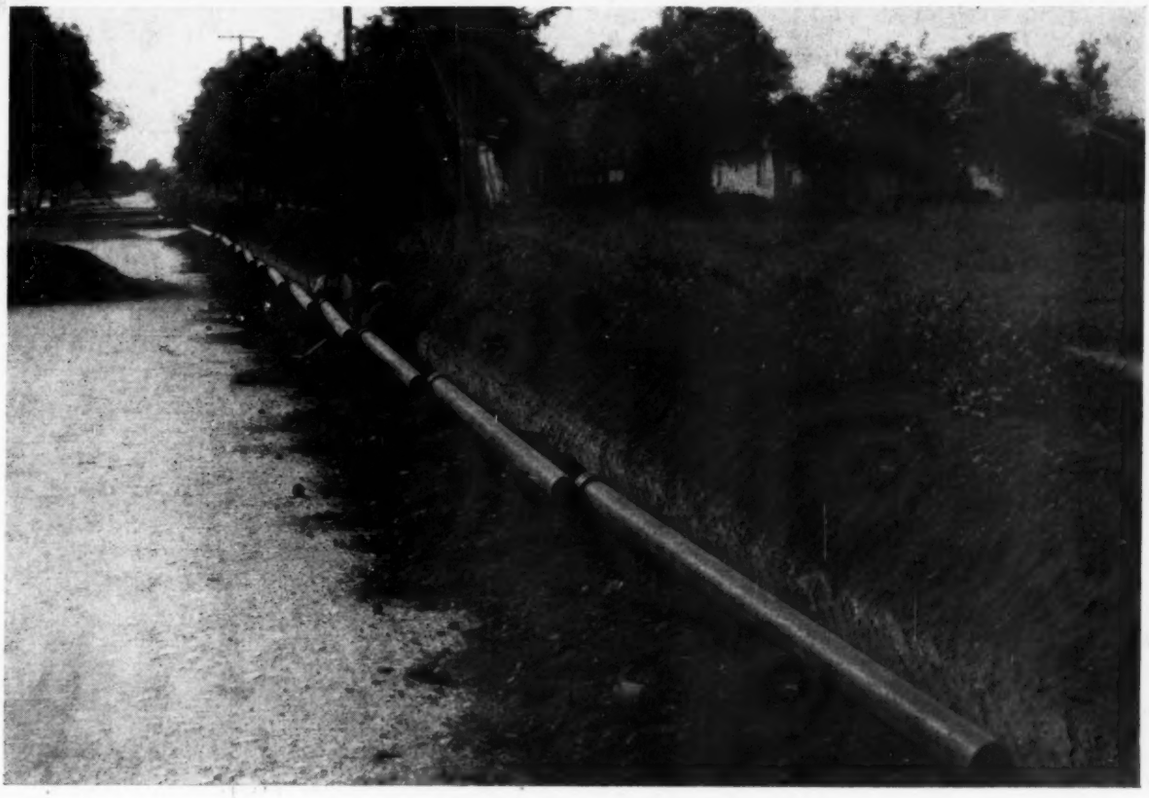
AUG 24 1925

PUBLIC WORKS

CITY COUNTY STATE



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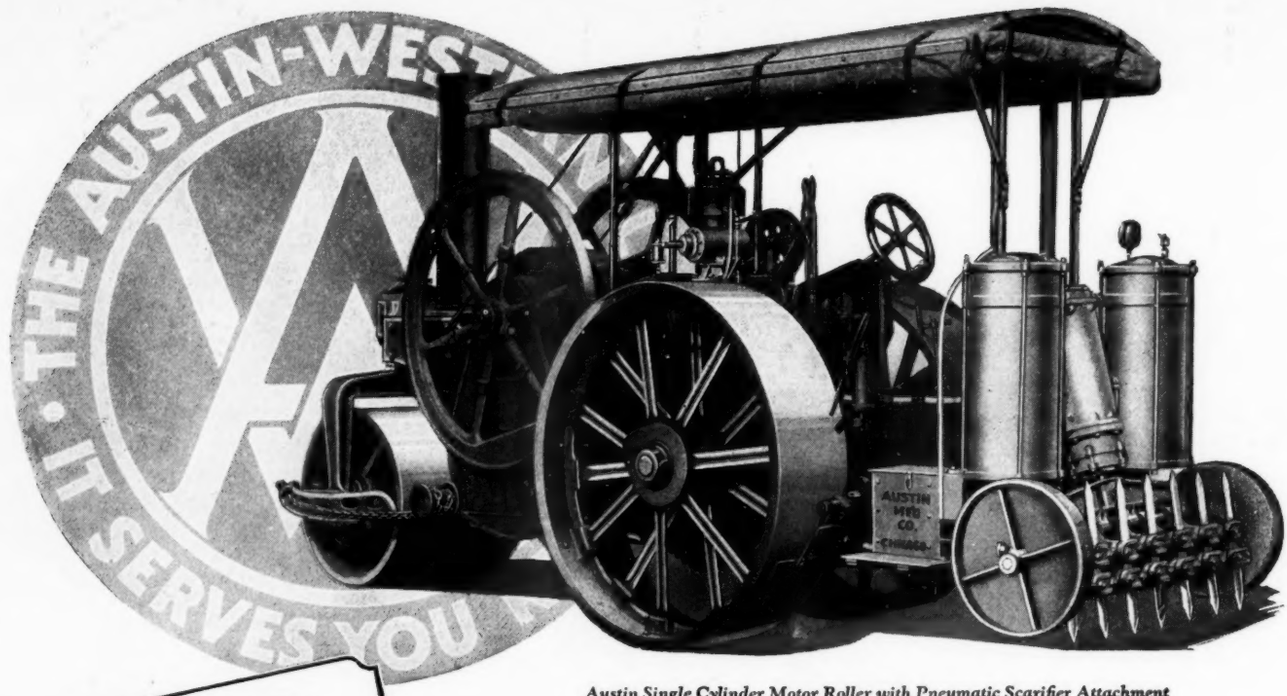
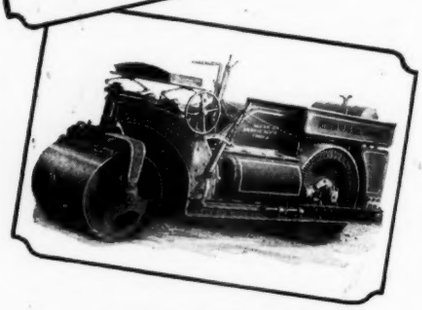
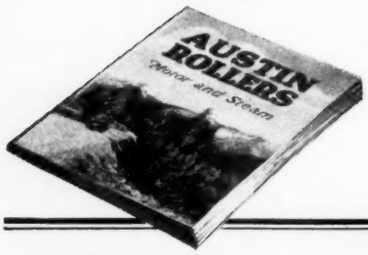


Austin Single Cylinder Motor Roller with Pneumatic Scarifier Attachment



Above: Austin Steam Roller with Scarifier Attachment.

Below: Austin 2-Cylinder Tandem Motor Roller.



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Vol. 56 AUGUST, 1925 No. 8

Denver's New Water Supply Conduit

Part of seven-million-dollar water works improvement program. Line of sixty-six inch reinforced concrete pipe, laid in tunnel and in wet and dry open trench, and steel creek crossing.

One of the larger and more important jobs included in the Denver Board of Water Commissioners' seven-million-dollar program of improvements and extensions, now rapidly approaching completion under the supervision of Burton Lowther, chief engineer, is the new conduit from Marston lake to the southwestern edge of the city. This conduit is a 66-inch, precast, reinforced concrete pipeline, slightly more than six miles long. It connects the clear water reservoir at the new Marston lake filter plant with the city mains at West Alameda avenue and So. Hooker street.

Marston lake, which is located near Fort Logan, about six miles south of the west section of Denver, is a 6½ billion gallon impounding reservoir. It is fed by conduits heading on the South Platte river about 23 miles southwest of Denver. Flow in the South Platte is maintained by Lake Cheesman, the 26 billion gallon storage reservoir which forms the basis of Denver's water supply system.

Plans for the new conduit were made a little more than a year ago. They are based on a required capacity of 80 million gallons a day, more than twice the capacity of the 48-inch wood pipe line which has been supplying this section of Denver and which will be used as an auxiliary supply when the new line is put into operation. Water will be delivered to the city mains under a head of approximately 120 feet, or about 50 pounds pressure. Maximum static head on the new line will be about 190 feet.

Briefly speaking, the job included 200 feet of wet open trench work at the Bear Creek crossing; approximately 3,200 feet of open trench work through muck deposits in the Bear Creek valley; 575 feet of tunneling through clay strata at Loretto Heights; a little more than 28,000 feet of dry open trench work requiring some scattered rock excavation; and the installation of necessary valves, Y connections, reducers, surge tanks, blow offs, and so forth. At the Bear Creek crossing steel pipes, 7/16 inch thick, were placed on two rows of timber piles, and encased in concrete, as shown in the accompanying cross section, Figure 1. In the tunnel section, 84-inch reinforced concrete pipes were laid, instead of 66-inch, and 54-inch Y connections placed at the ends. Figures 2 and 3 illustrate the construction at the south end of the tunnel. Horizontal stem, by-pass valves were

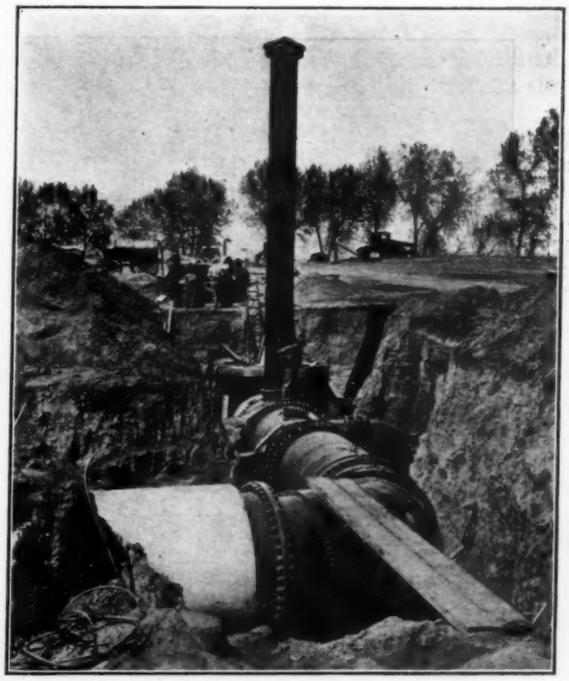


FIG. 2—SURGE TANK, VALVES, AND STEEL SPECIALS AT SOUTH END OF TUNNEL.

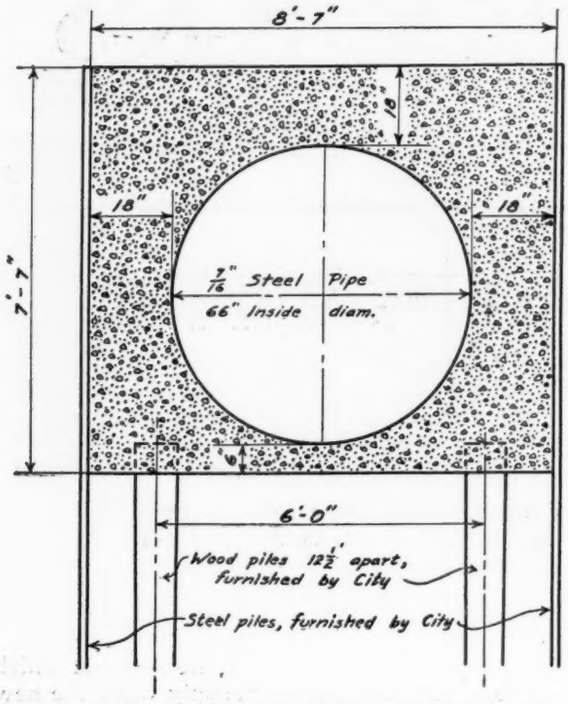


FIG. 1—CROSS-SECTION SHOWING CONSTRUCTION AT BEAR CREEK CROSSING

used; and all steel specials were encased in reinforced concrete,—at both ends of the conduit as well as at the ends of the tunnel.

The 84-inch pipe was laid through the tunnel so that additional tunnel work will not be necessary at some future date when the growth of the city requires the construction of another conduit. When that time comes a 54-inch conduit will be built and connected to the 54-inch Ys at the tunnel ends, the 84-inch pipe through the tunnel being large enough to carry the combined flow of both conduits. A right-of-way 100 feet wide, sufficiently wide to accommodate another conduit, was obtained by direct purchase, easement, or condemnation proceedings. The agreement with the land owner was generally drawn so that the owner, or former owner, in the case of direct purchase, pays the taxes and has the use of the land with the provision that employees of the Water Commission can enter on the premises at any time, to make any inspections or to do any necessary work.

THE CONCRETE PIPE

Bids for both steel and concrete pipe were received July 21, 1924; and the contract was awarded to the Lock Joint Pipe Company August 2. Construction operations were started promptly and the job was completed about June 1, 1925. The unit price for open trench work, exclusive of the Bear Creek crossing, was $26.90 a lineal foot. This was for completed conduit, including excavation, furnishing and laying pipe, and backfilling. The total cost of the work, including special connections, extras and so forth, amounted to a million dollars in round numbers.

Pipe were cast in 12-foot lengths, with 6½-inch walls, at a one-unit plant located near Fort Logan. According to Wm. B. Freeman, the contractor's Denver representative, two 8-hour shifts of 50 men each made 24 lengths of pipe every day. The first shift, which came on at 4:30 a. m. and worked until 12:30 p. m., with half an hour off for breakfast, removed the forms from the sections cast at least 12 hours earlier, cleaned and oiled them and got them ready for the next pouring; while the second shift, which came on at 12:30 p. m. and worked until 9 p. m., poured the concrete and tipped the pipe cast more than 48 hours before.

Pouring of the tops, or spigot ends of the pipe, could not be completed until late in the evening, because of settlement and shrinkage in the forms. Spigot ends were poured with an extra rich mix, just before the main body of the concrete had attained its initial set. The average mixture was a little richer than 1-1½-2½, since 2¾ barrels of cement were used to a cubic yard of concrete. When the pouring had been finished, the forms were covered with canvas and the pipe cured with steam for at least 48

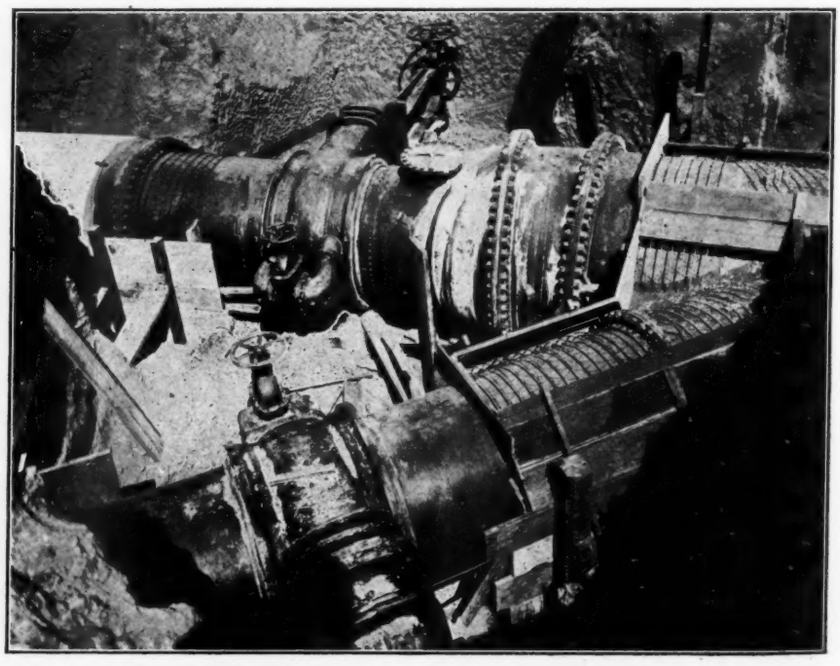


FIG. 3—STEEL SPECIALS WERE ENCASED IN REINFORCED CONCRETE. AND HORIZONTAL-STEM BYPASS VALVES WERE USED.

hours. Pipe sections were cast on the two sides of a gantry track; and the forms, concrete, and so forth, were handled by a traveling crane. Figures 4 and 5 illustrate the plant methods.

Pipe sections were reinforced with an inner cage of number 31 American Steel Wire mesh, and an outer cage of ¼" by 1", or ½" by 1¼", transverse hoops, held in place by wiring to four longitudinal bars, holes being punched in the bars at equal spaces, by a gang punch, to furnish anchorages for the wires. All hoops were electrically welded, and all welds were tested up to 15,000 pounds per square inch tension. Figure 6 shows the testing operation, the strain being applied by an ingenious lever arrangement. The reinforcing was designed so that the stress in the steel will not exceed 12,000 pounds per square inch under static head, or 10,000 pounds per square inch under operating head. There is approximately one ton of reinforcing steel in each pipe manufactured for the maximum head, and each pipe weighs approximately nine tons. The joint is the lead and steel type mentioned in the article on the Spavinaw Water Supply Project, published in the January issue of Public Works.

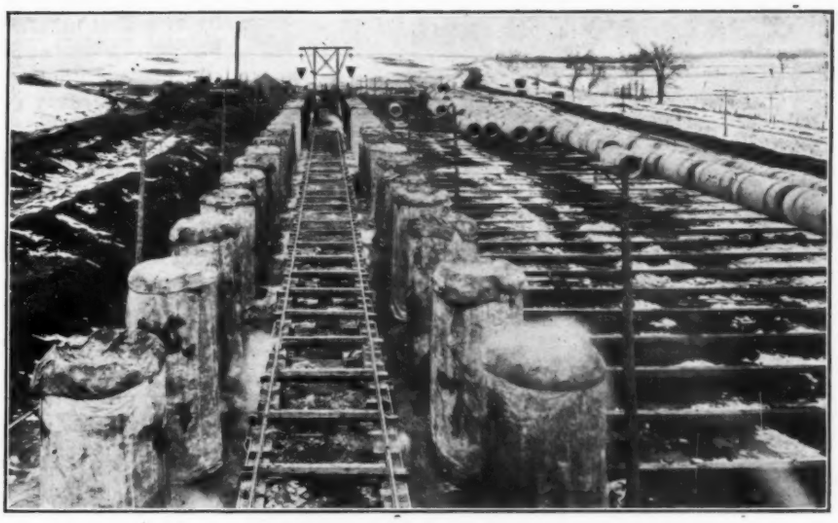


FIG. 5—PRECAST PIPE BEING CURED WITH STEAM

Pipe were hauled from the plant to points along the line over a narrow-gauge railroad, by a dinkey locomotive, from two to four sections being hauled at a time. Since the tunnel cross-section at Loretto Heights was large enough to pass the dinkey, the railroad was located through the tunnel rather than over the hill. Figure 7 shows the dinkey with two sections of pipe entering the tunnel.

TUNNEL WORK

H. R. Phillips, a local tunnel contractor, did the tunnel excavation and timbering, under a subcontract, at a unit price of $35 a foot. Five men, using hand steel, completed a length of about ten feet a day, hauling the material out in small cars. Figure 8 is a cross section of the excavation showing dimensions and method of timbering. After the pipe had been laid through the tunnel the remaining cross section was backfilled with concrete, leaving side and top timbers in place. All floor timbers were removed so that no vertical settlement, such as might result from decaying wood, can ever occur. Concrete was mixed on the ground surface; poured into the tunnel through 6-inch well casings, sunk at 25-foot intervals; and shovelled into final position. It was first planned to complete the backfilling in two lifts, but when the

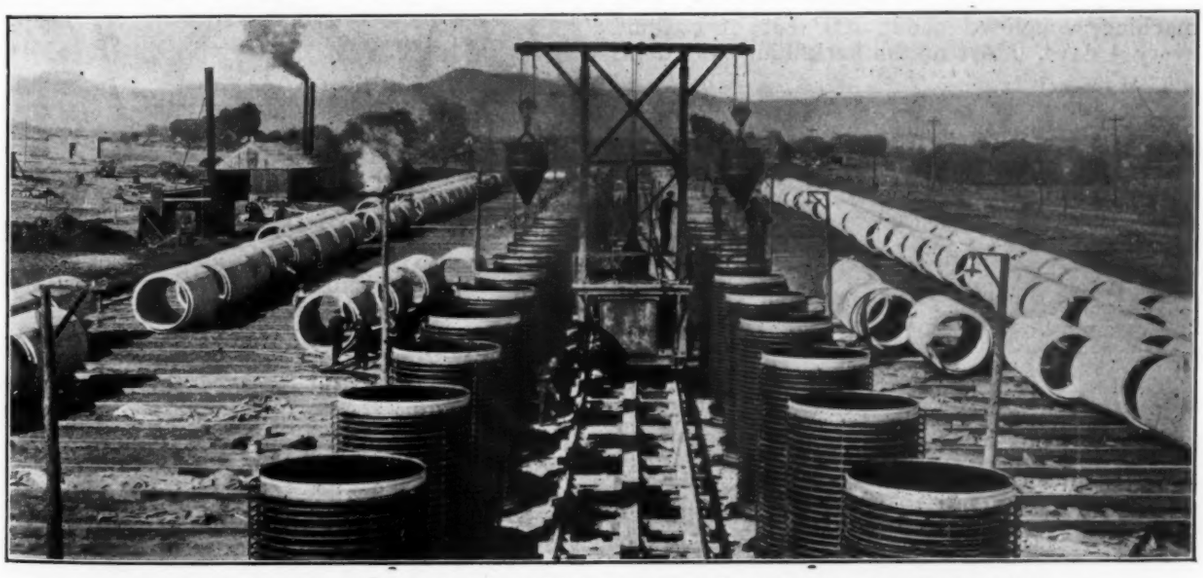


FIG. 4—MANUFACTURING THE 66-INCH PRECAST, REINFORCED CONCRETE PIPE.

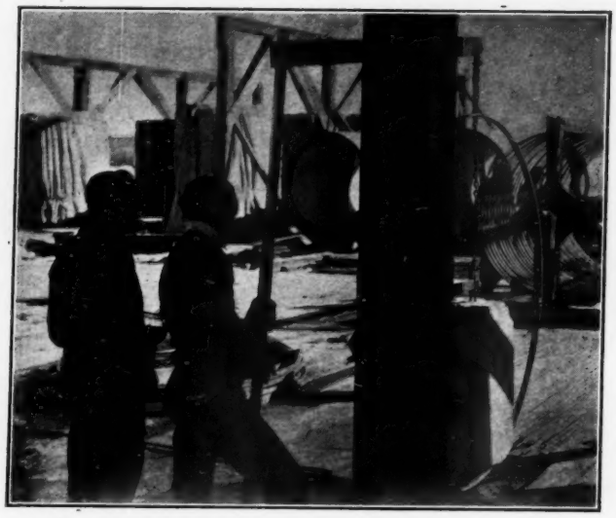


FIG. 6—TESTING WELDS IN TRANSVERSE HOOPS.

work was started it was found better to use three. The first lift filled the area below the springing line, the second completed the filling up to the top of the pipe, and the third, the remaining space up to the top of the tunnel.

TRENCHING.

Open trench, except in the Bear Creek valley, was excavated by two machines of the pull bucket type, a 1-yard Northwest shovel and a ½-yard Keystone. Pipes were laid by the 25-ton American crane shown in figure 9. This machine was later mounted on crawlers. Sometimes, when there was sufficient open trench ahead, as much as 800 or a 1000 feet of pipe was laid in a day. The two excavating machines were frequently delayed by running into rock which required drilling and blasting. In the Bear Creek valley, where piling was necessary, a 10-ton American crane, mounted on crawlers, drove the steel sheet piling; excavated the trench with a clam shell bucket; and placed the pipe. This machine completed about 200 feet of conduit every 4 days. Most of the backfilling was done by the 25-ton crane, equipped with a large drag bucket. Figure 10 is a typical cross section of the open trench excavation.

Shovel crews consisted of about 5 men each, including a shovel operator, a helper or fireman, and about 3 laborers who trimmed the trench to its final shape and did whatever other work was required. The laying crew included about 11 men, a foreman, 2 men on the crane, 2 men pouring mortar in the outside joints, and about 6 men laying cradle, helping place pipe, and doing miscellaneous odd jobs. Caulking was done later, as a separate operation.

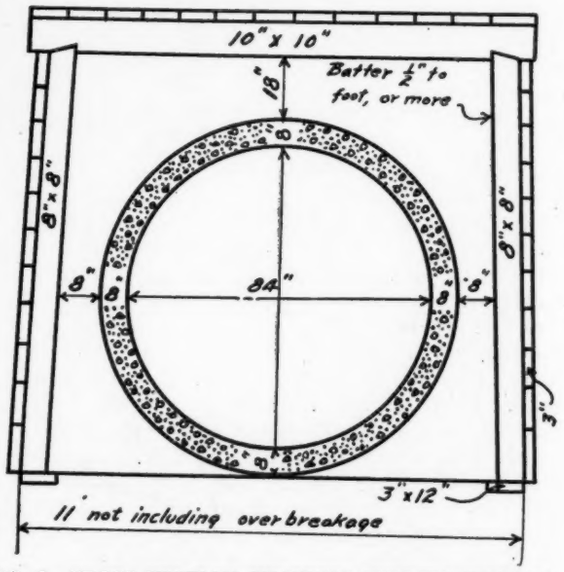


FIG. 8—CROSS-SECTION SHOWING TUNNEL EXCAVATION AND TIMBERING.

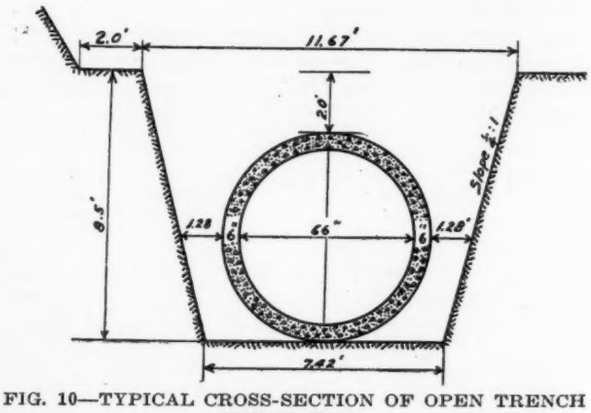


FIG. 10—TYPICAL CROSS-SECTION OF OPEN TRENCH EXCAVATION.

FIG. 7—HAULING PIPE THROUGH TUNNEL AT LORETTO HEIGHTS.

Practically the entire line was laid on a gravel cradle. About two feet of backfill was placed over the pipe, and allowed to stand for a time, before the joints were caulked, thus allowing the pipe to settle to a firm bearing before caulking. Joints were caulked from the inside, by driving home a flexible, fibre-filled lead gasket, which was inserted in the joint at the time of laying. The remaining space between pipe sections was then filled with cement mortar, so as to give a smooth, continuous inside surface. Mortar was carried along the interior of the pipe in a small rubber tired wagon. The men who placed the mortar found, after some prac-

tice, that by kneading the mortar to a certain consistency, they could throw it into the joints above their heads in such a way that it would stick in position. Finishers smoothed off the mortar, and brought it into line with the inside of the pipe just before the initial set was reached. A thin mortar was poured into the joints from the outside, before any backfill was placed, wrapping a strip of burlap around the pipe at the joint to hold the mortar in the joint.

The contract provides that leakage must not exceed 180 gallons per inch of pipe diameter, per mile, per day. While testing has not been completed at time of writing, a similar, 54-inch line, laid about a year ago, tested well under the specified limit.

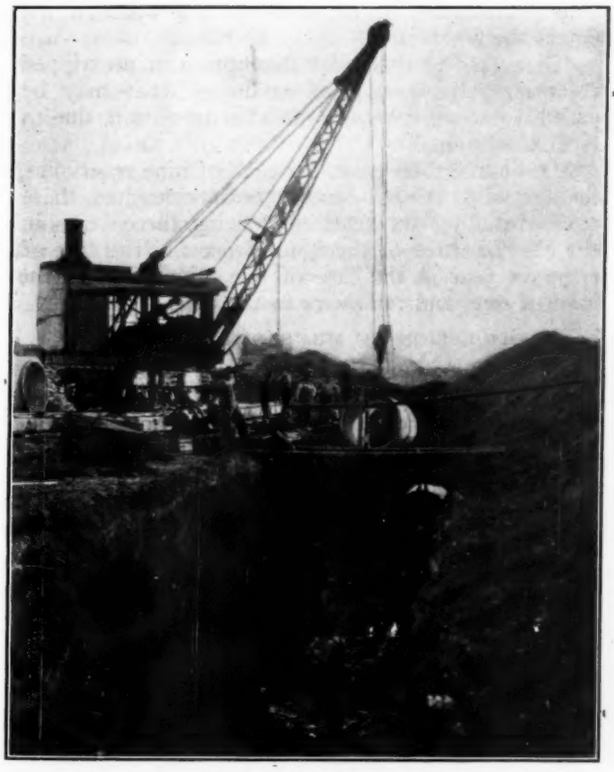


FIG. 9—25-TON CRANE STARTING TO LAY PIPE AT THE MARSTON LAKE END OF THE CONDUIT.

D. D. Gross office engineer, and T. J. Leahy, assistant engineer in charge of the work, supplied the foregoing data.

Toledo Street Department's Activities

In his report for the year 1924 S. A. Foster, street commissioner of Toledo, Ohio, "points with pride" to a reduction in the expense of the department of $71,646 as compared to 1923, or more than ten per cent. This was effected "despite the fact that we had additional territory which increased our expenses. . . . A great amount of this saving is due to the fact that we were furnished with one motor driven power sweeper and one sewer eductor. The cost of same was saved in a few weeks. I would recommend the purchase of two more sweepers and one eductor, which would eliminate working our machine sixteen hours per day and enable it to get the proper repairs and attention."

The motor-driven sweeper was operated two shifts a day with two men to a shift. In addition there were used during the summer months four crews of eight men each. "White wings" were used in the business district and in "the residential sections where this class of service has been requested." An average of 30 men and 3 single rigs were used in this service. During the winter months 5,384 loads of snow were removed from the streets in the business district.

In cleaning catch basins, three men and a single rig were employed on the East Side and the sewer eductor with three men on the West Side. The latter cleaned 3,698 catch basins, while 70 were cleaned by spoon and 12 by windlass, this gang also cleaning and flushing 95 sewers and cleaning 8 others by machine and 39 by pipe.

Garbage is collected by city-owned teams and trucks and hauled to the disposal plant, where part is delivered to the Pan-American Feed & Milling Company, and what that company cannot take care of is hauled onto farms and plowed under, which rehauling requires two extra teams during the heavy season. Thirty teams and wagons, six 1-ton Ford dump trucks and two Ford roadsters, with an average of 60 men, drivers and helpers and 3 foremen, collected 16,015 loads, estimated to weigh 33,931 tons. Collection cost $89,934 for labor, $6,754 for supervision, $973 for clerk hire and $14,531 for miscellaneous supplies. Disposal cost $12,394.

Horses and other large animals are removed by a private company without cost to the city, but the Street Department collected 3,698 dogs, 1,105 cats, 47 chickens, 50 rabbits and 288 guinea pigs.

The horses and mules used by the department, numbering 100, are cared for in city stables by twelve men and a foreman, and all shoeing for this and other departments is done by a horseshoer and floorman. In the blacksmith and wagon shop one floorman, one wagonmaker and one blacksmith do all rebuilding and repairing of wagons, sprinklers and other vehicles, and repairing of tools and implements. A carpenter and a painter do all of the work of these kinds required by this and other departments.

Change in Soil Testing Methods Contemplated

In making a subgrade survey it is essential that the various soil types occurring along the proposed locations be determined, as well as the physical properties of the respective types. The determination of these two factors requires that a large number of soil samples be taken and analyzed in the laboratory.

It would seem advisable to adopt any means by which the time and labor involved in sampling and analyzing could be reduced to a minimum, and the surveys of the United States Bureau of Soils which cover a large part of the United States would seem to be of inestimable value to the highway engineer for this purpose.

Unfortunately the test methods used by the Bureau of Soils, especially in the mechanical

analysis test, differ from those which have been standardized in highway engineering laboratories. The former involve the use of millimeter sieves for separating the fractions of the soil, while the latter are based on sieves the meshes of which are measured in English units. On account of this difference in practice materials which are classified as clay, silt, loam, and sand by the Bureau of Soils are not identical with the materials to which the same names are applied by highway investigators, and this difference stands in the way of a convenient use of the large amount of useful information acquired by the agriculturists.

The article published in this issue * makes out a convincing case for the use of the Bureau of Soils bulletins. It does not seem that a difference in method so slight and so easy to eliminate should be permitted indefinitely to embarrass the utilization of such valuable and voluminous data; and the Bureau of Public Roads is contemplating a change in its methods of making the mechanical analysis which will bring them into conformity with the methods of the other Federal bureaus. There are a number of considerations both for and against the change which will make it necessary to give the matter very careful consideration, and final action will not be taken until the advisability of the change has been fully demonstrated. In the meantime the bureau will welcome the advice and suggestions of highway and testing engineers either for or against the proposal.

From the July issue of "Public Roads," the official publication of the U. S. Bureau of Public Roads.

Color of Reservoir Water

Data obtained from investigations of Connecticut reservoirs and others. Several years required for color of a reservoir to reach its minimum.

In a paper before the New England Waterworks Association entitled, "Color and Other Phenomena of Water from an Unstripped Reservoir," Caleb M. Saville, chief engineer of the Hartford, Conn., Water Department, gave data concerning this subject obtained from investigations of a number of reservoirs, and records concerning the same, but with special reference to the Nepaug reservoir, Hartford. The facts were presented "without argument and merely for the purpose of putting them on record" but at the end he presented a conclusion of his own as follows:

"It appears that in a reservoir similar to that of the Nepaug reservoir of the Hartford water supply system, and with similar conditions of inflow, after five or six years the reservoir gets conditioned, as it were, although for several years longer there will be a gradual decrease in the color content of the stored water.

*The July issue of "Public Roads."

"The data presented in this study substantiate the conclusions of that master of water supply phenomena, Frederick P. Stearns, that when an unstripped reservoir is first filled, the water acquires, after standing for a time, a considerable amount of color, chiefly from vegetable matters which have been flooded. Some of the color taken up is removed by the bleaching process which goes on in reservoirs where the water is stored for a long time. In the early years more color is taken up than is removed and the residual color is greater than the average color of the inflowing streams. As the years pass, the amount of coloring matter acquired from the bottom and sides of the reservoir diminishes, while the bleaching process is continually going on, so that after a term of years the result of storage is a decided diminution of the color of the water which enters the reservoir.

"In regard to this color diminution in unstripped reservoirs, the period of attaining what may be called a normal color is somewhat uncertain, due to local conditions."

Mr. Saville then gave, for each of nine reservoirs, the age when normal conditions were reached, these ages averaging six years, and being three years in the case of three of them, four years in the case of two, six year in the case of one, nine years in the case of one, and ten years in the case of two.

DISCUSSION OF MR. SAVILLE'S PAPER

Additional interesting facts and opinions were contributed by other members in the discussion. Robert Spurr Weston stated that the time required to overcome the effect of vegetation in coloring water depends largely upon how long these peaty areas continue so to act; but that ultimately ooze deposited by the water as a result of oxidation of organic matter would act like a blanket on the peat deposits, causing the reservoir to function much as if it had been stripped previously. This could not always be relied upon, however, as a reservoir near New Haven which he had been studying failed to reach this condition after nearly two years. He offered as a posssible explanation of this the fact that one feeder enters near the reservoir outlet and only a small part of the storage of the reservoir is effective in oxidizing its coloring matter. He said that the long time required for the Nepaug reservoir to reach normal condition might be due to the same cause.

Stephen De M. Gage told of some experiments conducted by himself and Mr. Clark at the Lawrence Experiment Station which indicated that when any container of water such as a reservoir first goes into service the number of bacteria decreases enormously to a point as low as, or lower than they were at the start; this phenomenon appearing to be entirely independent of the size or shape of the container. Since the reduction in color in a reservoir is probably due to destruction of organic matters by bacterial fermentation, he suggested that this phenomenon of bacterial increase and decrease might account, in part at least, for the color phenomena cited by Mr. Saville.

This paper was read on November 11 and Professor George C. Whipple was one of those enter-

ing into the discussion. As Professor Whipple died on November 27, this is one of the latest if not the last contribution which he made to engineering knowledge. He stated that changes in the color of streams, and especially small streams, occur so rapidly that weekly or monthly determinations are of little value as a basic of estimating the probable future color of stored water, but that daily observations are desirable. He cited two instances that indicated that too much emphasis is sometimes given to the so-called bleaching effect by sunlight. Certain reservoirs had shown a color at the lower end which agreed quite well with the weighted average of figures obtained by making frequent color analysis of all the streams entering the basin and making due allowance for clear water entering through the ground. He also stated as a well established fact that fresh vegetation contributes more color to water than old peaty matter and humus.

Charles W. Sherman stated that the Ashby reservoir of the City of Fitchburg reached a permanent color condition in about three years. The site was not stripped but all trees and bushes were removed and roots grubbed and burned. About 35 of the 153 acres covered was swampy land, while 85 acres had formed the bottom of a mill reservoir fifty years old or more.

Clarifying Colored Waters

Study of the removal of colors in waters originating in swamps and peaty soils has been made by Lewis B. Miller, chemist of the hygenic laboratory of the U. S. Public Health Service, and described by him in "Public Health Reports" for July 10.

Since the presentation by Thorndike Saville, in 1917, of his paper, "On the Nature of Color in Water," before the New England Water Works Association, the color in such waters has been regarded as held in a colloidal state, and this study appears to confirm this view. The coloring matters appear to belong to the group known as humic acids.

Samples of water so colored were studied by dialysis, by cataphoresis, and by the effect of various chemical reagents upon the stability of the color in solution. In every case the color was proved to be present as negatively charged colloid. The coagulation and removal of the color (formation of the "color floc") by electrolytes was shown to be effected by the cation.

With respect to the clarification of colored waters by alum, it was suggested that the clarification was due to aluminum ion and that "alum floc," which is effective in the clarification of turbid water, had an unimportant role in the removal of "colors" of this type.

Pressure Against Retaining Walls

Measurements of pressure made with soil pressure cells by Bureau of Public Roads indicate that drainage of soil behind wall is of great importance. Also that too small constants are often used in standard formulas.

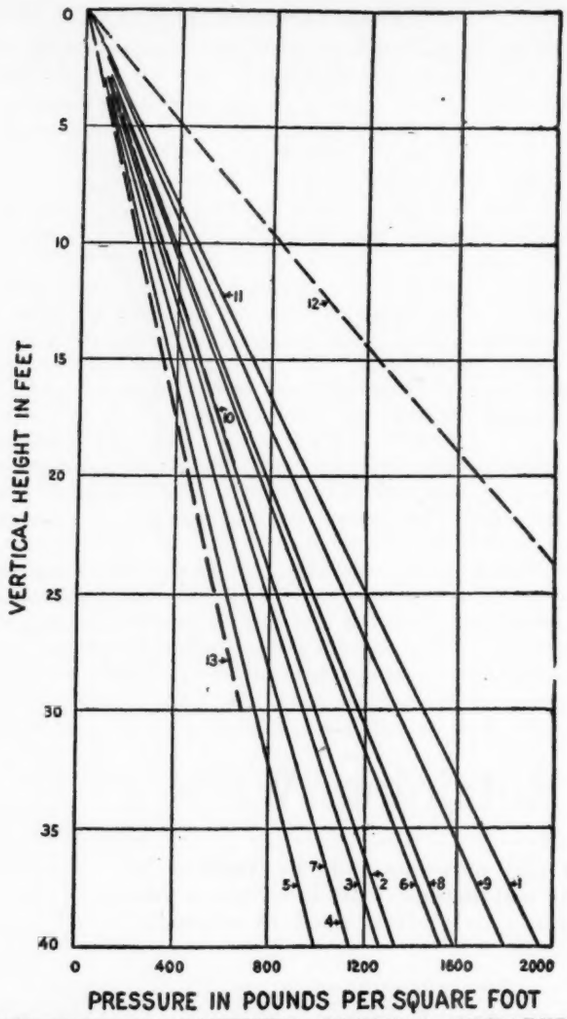
The different theories for determining the pressure of filling material against retaining walls that are in general use give comparable results, provided the assumptions are the same; but variation in results is caused by variation in the values assigned to the constants of the formulas. Standard specifications of several of the States give constants to be used, which range from the pressure that would be caused by a fluid weighing fifteen pounds per cubic foot to that which would be caused by a fluid weighing thirty-six pounds per cubic foot. Occasional partial or complete failures would indicate that in many instances the constants are not properly chosen. The Bureau of Public Roads has made measurements of the force exerted by a fill against an abutment or retaining wall under actual working conditions, using the soil pressure cell in which the pressure is maintained and measured by means of air pressure. These tests are described by J. V. McNary, highway project engineer of the U. S. Bureau of Public Roads, in the July issue of the official publication of the Bureau, "Public Roads."

The conclusion drawn from the actual tests is that "the pressure of earth against a retaining wall should not under ordinary conditions be assumed to be less than that which would be developed by a fluid weighing thirty pounds per cubic foot." Fully as important is the very definite indication that a direct relation exists between high pressure and high moisture content of the filling behind the wall, showing the importance of suitable provisions for draining the fill. In fact, says Mr. McNary, "Such provisions should be regarded as major features of the work of equal importance with the design and construction of the wall itself."

Tests were made on four bridges, two in Washington, D. C., one at the Arlington Experimental Farm, and a fourth at the Skellit Fork bridge near Wayne City, Illinois. Only two of these, at the Sixteenth street bridge at Washington and the Skellit Fork bridge, are discussed by Mr. McNary.

SIXTEENTH STREET BRIDGE TEST

The former of these is located on a hill side, the ground falling rapidly towards the abutment at which the tests were made. The abutment intercepts the ground water flow and surface drainage from the long hill above, but with no provision for draining the fill in either abutment or wing walls. The filling material was of a clayey nature and thoroughly compacted by ramming in one-inch to three-inch



PRESSURES BY RANKINE'S FORMULA COMPARED WITH THOSE DETERMINED BY TESTS OF BUREAU OF PUBLIC ROADS.

Results from Rankine's formulas shown by solid lines, as follows:

(1) Worst case of "ordinary earth, wet; weight per cubic foot, 120 pounds; angle of repose, 25°." Equivalent to fluid weighing 48.7 pounds per cubic foot. Hool and Johnson Concrete Engineers Hand Book.

(2) Most favorable case of "ordinary earth, wet; weight per cubic foot, 100 pounds; angle of repose, 30°." Equivalent to fluid weighing 33 1/3 pounds per cubic foot. Hool and Johnson Concrete Engineers Hand Book.

(3) Retaining wall fill, weighing 100 pounds per cubic foot; angle of repose, 30°. Equivalent to fluid weighing 33 1/3 pounds per cubic foot. Author gives C = 16. Equivalent to fluid weighing 32 pounds per cubic foot. Passwell.

(4) Customary assumptions; fill weighing 100 pounds per cubic foot; angle of repose, 1½ to 1 = 33° 40'. Equivalent to fluid weighing 28.7 pounds per cubic foot.

(5) "Dry earth; weighing per cubic foot, 100 pounds; angle of repose, 36° 53'." Equivalent to fluid weighing 25 pounds per cubic foot. American Civil Engineers Pocket Book.

(6) "Mud; weight per cubic foot, 100 pounds; angle of repose, 26° 34'." Equivalent to fluid weighing 38.2 pounds per cubic foot. American Civil Engineers Pocket Book.

(7) "Sand, gravel, and clay; wet; weight per cubic foot, 115 pounds; angle of repose, 36° 53'." Equivalent to fluid weighing 28.7 pounds per cubic foot. American Civil Engineers Pocket Book.

(8) "Soil dumped into water; weight per cubic foot, 70 pounds; angle of repose, 15° 57'." Equivalent to fluid weighing 39.5 pounds per cubic foot. American Civil Engineers Pocket Book.

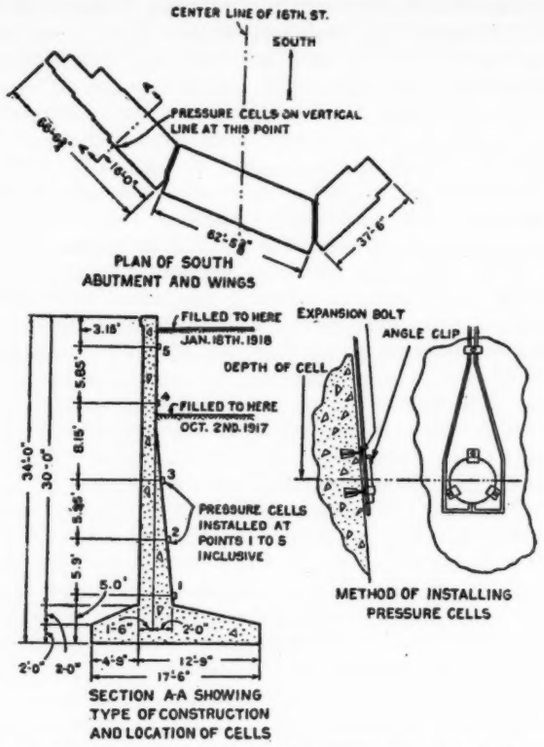
(9) "Clay dumped into water; weight per cubic foot, 80 pounds; angle of repose, 15° 57'." Equivalent to fluid weighing 45 pounds per cubic foot. American Civil Engineers Pocket Book.

(10) Bureau of Public Roads tests, Bennings Road Bridge, D. C. Equivalent to fluid weighing 33.4 pounds per cubic foot.

(11) Bureau of Public Roads tests, Sixteenth Street Bridge, D. C. Equivalent to fluid weighing 48.4 pounds per cubic foot.

(12) Bureau of Public Roads tests on hydraulic fill of clay. Equivalent to fluid weighing 84.5 pounds per cubic foot.

(13) Bureau of Public Roads tests, Skellit Fork Bridge, Wayne City, Ill.; low moisture content in filling material; no rain between time of filling and date of readings. Equivalent to fluid weighing 23.2 pounds per cubic foot.



PLAN OF ABUTMENT AND SECTION OF WING WALL OF SIXTEENTH STREET BRIDGE

layers. Five soil pressure cells were located behind the wall, one about one foot above the top of the footing and four more at intervals of approximately 6 ft., 6 ft., 8 ft. and 6 ft. respectively, the top one being about eight inches below the top of the fill. Readings on these made when the filling was about three-fourths completed showed the maximum pressure to be at the bottom cell. Eleven readings were taken after the completion of the fill during a period of about fifteen months, and while all other cells showed increased readings, no increase was shown at the bottom cell, probably due to friction of the fill on the footing; the pounds pressure per square inch, in fact, decreasing from 6.3 to about 5.5 the first eight months. However, a reading taken on December 20th, six days after a precipitation of 2.87 inches, showed the pressure increased to 6.65, an increase of about 15%, which was due apparently to increased moisture content.

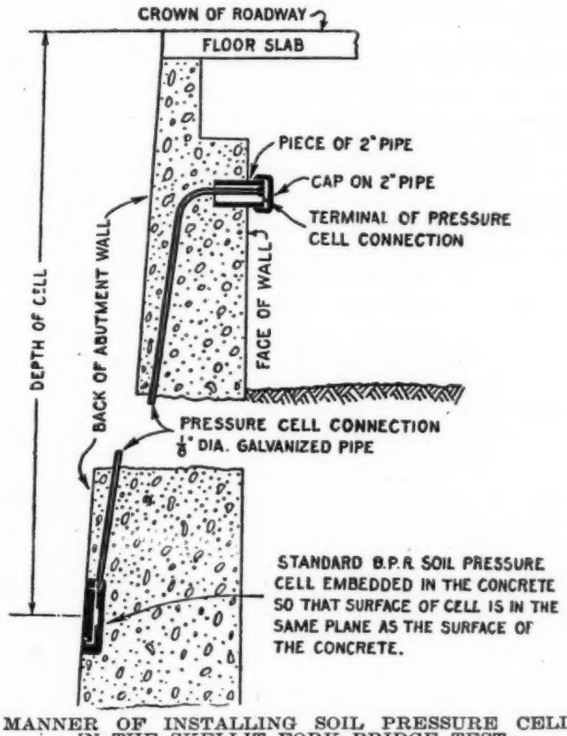
Pressures on the cells at the other elevations practically doubled during the first eight months, probably due to gradual consolidation of the fill, and these also showed a considerable increase at the December reading due to the water absorbed by the fill.

The pressures in the different cells showed some irregularity at different times but in general they increased uniformly from top down to the cell seven feet above the bottom, decreasing from there to the bottom cell, this decrease probably being caused by friction as noted above.

The total observed pressure on the wall has been calculated by Mr. McNary for each of the

observations and expressed in terms of the weight of an equivalent fluid. For this bridge these fluid weights in pounds per cubic foot began at 48.8 on the completion of the filling and gradually decreased to about 45, increasing to 54.4 after the heavy rain refered to.

"Although on good foundation material and of a cross-section that should satisfactorily support the ordinarily assumed loads, the wall has moved outward at the top about two inches, thus confirming the presence of the unusually high pressures shown by the pressure cells." That considerable ground water is intercepted by the wall is indicated by the fact that the joint between the wing wall and the abutment dis-


CROWN OF ROADWAY
FLOOR SLAB
PIECE OF 2" PIPE
CAP ON 2" PIPE
TERMINAL OF PRESSURE CELL CONNECTION
FACE OF WALL
BACK OF ABUTMENT WALL
DEPTH OF CELL
PRESSURE CELL CONNECTION
⅛" DIA. GALVANIZED PIPE
STANDARD B.P.R. SOIL PRESSURE CELL EMBEDDED IN THE CONCRETE SO THAT SURFACE OF CELL IS IN THE SAME PLANE AS THE SURFACE OF THE CONCRETE.

MANNER OF INSTALLING SOIL PRESSURE CELLS IN THE SKELLIT FORK BRIDGE TEST.

charges seepage throughout the entire height. Consultation of the Weather Bureau records shows that the higher pressures were those recorded after a period of several days precipitation and the lowest pressure at the end of a period of no precipitation.

SKELLIT FORK BRIDGE TEST

The filling behind the Skellit Fork bridge is on a level grade raised a few feet above high water where it crosses the flood plain, which is subject to inundation practically every spring. The abutment is 32'3¼" from the top of the footing to the grade line. Weep holes were constructed six feet above the top of the footing, others 3 ft. 9 in. above these and still a third row about six feet higher.

Observations of this bridge began after the filling had been completed but a short time, there having been no rain since the filling had been made, and continued for about eighteen months. Probably because of the presence of the weep holes which drain off the water, pressures at the different elevations ran quite irregular; also for the same reason not so much increase was caused by rain falls. The pressure at the bottom immediately after the filling had been completed registered 5.8 pounds, which increased to 9.7 five and one half months later, within 24 hours after high water had receded from the abutment; but a month later had fallen to 7.8 and remained at approximately this point.

The weep holes consisted of openings through the wall without any provision for conducting seepage to them. Had such provision been made it probably would have reduced considerably the pressures recorded at points a short distance below each set of weep holes. Calculating, as in the previous case, the weight per cubic foot of a fluid that would give an equal total pressure, this is found to be 23.2 pounds on the completion of the filling, increasing to 44.1 when the fill was saturated with flood water and falling to 40 pounds and finally to about 30 pounds when this had drained out.

Contracting Ethics

Code of Practice for Contractors adopted by the Associated General Contractors of America.

Several national engineering organizations have, during the past few years, formulated codes of ethics to which the members of the several branches of the profession are expected to subscribe and conform. That contractors should do the same would have seemed surprising a generation ago and is a very significant sign of the wonderful progress that they have made in developing a professional consciousness as a preliminary to a professional conscience. The Associated General Contractors of America has had remarkable success in its efforts to elevate the standard of contracting in this country within the brief space of less than ten years, and the latest development in this progress has been the adoption of a code of practice for contractors. This code has been set forth in nineteen rules, of which all but five refer to relations between contractors on one side, and on the other side, owners and the public, the engineering and architectural professions, and subcontractors and those who furnish materials. The remaining five refer to the relations between members of the Association. These rules of practice are as follows:

OWNERS AND THE PUBLIC

"Fair and bona fide competition is a fundamental service of our industry to which clients and owners are entitled. Any act or method in restriction thereof is a breach of faith toward this Association and a betrayal of its principles.

"But the competition cannot serve its legitimate purpose

unless it operates under conditions alike fair to owner and to contractor.

"Observance of ethical conduct toward the contractor by those who utilize his competitive bidding will be encouraged in proportion as he himself abides by the ethics of fair competition. Only when he respects the code of this Association can he reasonably ask others to respect it.

"1. Competitive bids preferably should be submitted only when a definite time and place for the opening of all proposals has been fixed, at which all bidders or their representatives are permitted to be present.

"2. The contractor's professional knowledge is the result of his training and experience and if he is called upon for preliminary estimates or appraisals it is proper that he should be paid in the same manner that engineers and architects are paid for similar service.

"3. Bidders should neither seek nor accept information concerning a competitor's bid prior to the opening, nor by any method suppress free competition. It is equally improper for the owners to use bids in an effort to induce any contractor to lower his figures.

"4. On private work, if all competitive bids are rejected, new bids should not be submitted within 60 days unless warranted by a substantial change either in the work to be performed, or the market, or other basic conditions affecting cost.

"5. The amount of a bid should not be altered after the opening except when substantial change is made in the work, or when further bidding on alternate items is requested. In event of such change or further bidding, the contractor should bid only on the items specified and should increase or decrease the amount of his bid only in proportion to the change or alternate involved. Any reduction of a bid disproportionate to such change or the submission of any alternate which in effect produces such a disproportionate reduction, constitutes unfair competition. This shall not be construed as prohibiting the low bidder from decreasing his bid.

"6. Contractors should co-operate in advising architects, engineers and owners with respect to the relative costs of various alternates while plans are being prepared and thus seek to reduce the number of alternates to a nominal maximum.

"7. When bids are solicited and received by an owner on a lump sum basis, no competitor other than the low bidder should solicit the work on a percentage basis, or any other form of cost-plus contract, provided however, that any competitor shall have the right to accept the work on a percentage basis if tendered him without guaranteed maximum cost or at a guaranteed maximum cost not less than his original bid.

SUB-CONTRACTORS

"The operations of the contractor are made possible through the functioning of those agencies which furnish him with service or products, and in contracting with them he is rightfully obligated by the same principles and fair dealing that he desires should govern the actions toward himself of architects, engineers and client owners.

"Ethical conduct with respect to sub-contractor and those who supply materials requires that:

"1. Proposals should not be invited from any one who is unqualified to perform the proposed work or to render the proper service, or to whom, in event that his proposal should be the lowest received, the contractor would be unwilling to award the contract.

"2. The figures of one competitor shall not be made known to another before the award of the sub-contract, nor should they be used by the contractor to secure a lower proposal from another bidder.

"3. The contract should preferably be awarded to the lowest bidder if he is qualified to perform the contract, but if the award is made to another bidder, it should be at the amount of the latter's bid.

"4. In no case should the low bidder be led to believe that a lower bid than his has been received.

"5. When the contractor has been paid by a client owner for work or material, he should make payment promptly, and in just proportion, to sub-contractors sand others.

ENGINEERS AND ARCHITECTS

"Local and national cooperation in matters of mutual concern should be the basic policy of members of this Association in their relations with the engineering and architectural professions; the purpose of this cooperation being to establish a clear conception of respective functions and responsibilities, to guard against uneconomical or improper practices, and to carry out constructive measures within the industry.

"Ethical conduct toward architects and engineers demands the following:

"1. Support should be given to all efforts of these professions to maintain and extend high standards ot conduct.

"2. Contractors should give full credit to the value of the services rendered by the architect and engineer and neither undermine nor disparage their functions or usefulness.

Each of the sixty-three chapters of the Associated General Contractors of America has devoted its attention to a study of the code in meetings specifically set aside for the purpose. Conferences have followed in all parts of the country, with architects and engineers and sub-contractors being thoroughly acquainted with the details of the code and the determination to place the rules in effective application.

The code defines ethical conduct with respect to competitive bidding as follows:

"1. Competitive bids preferably should be submitted only when a definite time and place for the opening of all proposals has been fixed, at which all bidders or their representatives are permitted to be present.

"2. The contractor's professional knowledge is the result of his training and experience and if he is called upon for preliminary estimates or appraisals it is proper that he should be paid in the same manner that engineers and architects are paid for similar service.

"3. Bidders should neither seek nor accept information concerning a competitor's bid prior to the opening, nor by any method suppress free competition. It is equally improper for the owners to use bids in an effort to induce any contractor to lower his figures.

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"7. When bids are solicited and received by an owner on a lump sum basis, no competitor other than the low bidder should solicit the work on a percentage basis, or any other form of cost-plus contract, provided, however, that any competitor shall have the right to accept the work on a percentage basis if tendered him without guaranteed maximum cost or at a guaranteed maximum cost no less than his original bid."

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Prevention and Cure for Freezing of Water Pipes

Thawing water pipes is expensive, and frozen pipes are not only annoying but may constitute a fire hazard. In view of this, expense as well as forethought in taking measures to prevent freezing are justifiable.

Successful methods of prevention based on experiences in New England are described in this issue; special attention being paid to services and to pipes crossing bridges or in other exposed places. For the latter, Boston has evolved the plan of wrapping the pipe with three inches of felt, waterproofed with tar paper and protected with galvanized iron, the whole enclosed in a box.

Most interesting is the method described of using a mixture of hot tar and granulated cork. For mains, a thickness of 6 inches of this all around the pipe is used. For services this is reduced to 2 inches. This was said to have prevented the freezing of services that had formerly frozen every winter.

No figures of cost of the tar-and-cork method were given, but both materials are comparatively cheap. An eight-inch main would require about 2¼ cubic feet of the mixture per running foot; a service pipe about one-ninth of a cubic foot, or four or five cubic feet for a service. Most superintendents probably have found that a service that freezes once is very likely to acquire the habit. A comparison of the cost of digging up a service when the ground is frozen and thawing or replacing it, with that of placing four or five cubic feet of the tar and cork mixture around it, might indicate that it would be economy to so treat every service the first time it freezes and thus eliminate an indefinite number of repetitions. Frozen mains are more serious matters, and prevention rather than cure is to be sought by all means. Sufficient depth of compact earth cover is generally a sure preventive. Where this is not practicable precautions should be taken without waiting for the first freeze—the consequences of a frozen main are apt to be too serious to risk in order to save a few dollars.

Construction of Retaining Walls

An abstract given elsewhere in this issue of the report on tests of pressure of earth against abutment walls, which have been made by the U. S. Bureau of Public Roads, gives prominence to one feature that we think should be especially emphasized. This is the importance of making ample provision for draining away the water that will naturally collect behind every such wall except under special conditions of porous soil.

These tests showed that the pressures behind an abutment where no provision was made for draining off the water from behind the wall were about 50 per cent. greater than in the case of another abutment where weep holes had been provided. The tests also indicated quite clearly that, while the reduction of pressure in the vicinity of the weep holes was considerable, a similar reduction might have been made over practically all of the back of the wall had adequate provision been made for conducting the moisture to the weep holes from the whole of it. In fact, the figures seem to show that such provision would have reduced the pressure 50 per cent., making it about one-third of that registered by the pressure gauges on the wall where no draining at all had been provided.

An illustration of such practice is furnished by

a retaining wall built a few years ago in Pittsburgh and described in PUBLIC WORKS for September, 1922. In this wall a six-inch drain pipe was laid on top of the footing behind the wall, discharging into weep holes at intervals; while from this drain up to within a short distance below the top of the fill, broken stone was placed against the back of the wall to a thickness of nine inches.

Where an unusual amount of water is expected, or the soil used in the backfill is found to be very retentive of moisture, the additional precaution of placing horizontal layers of gravel or other comparatively porous material extending back several feet from the rear of the retaining wall, and located at intervals of a few feet, vertically, would aid in draining out the backfill and preventing the absorption of moisture which apparently greatly increases the pressure against the wall.

It should be remembered that a pressure dangerously high may need to exist for only a few minutes to overthrow a retaining wall, so that the important thing is to prevent the accumulation of water in the soil rather than to secure a gradual draining away of it. In special cases it might be worth while to bring coarse sand or gravel or other porous soil from a distance to be used for back filling. Calculations might indicate that sufficient could be saved in the lighter cross-section of wall which would be safe under this condition as compared to one where a water-retentive back filling is used, to more than pay the additional cost of importing porous back filling material.

Aggregates by the Ton or the Yard

Sand and gravel are sold by the cubic yard in some sections of the country and by the ton in others. For instance, Chicago, Dallas, Denver, Detroit, Grand Rapids, New York, and Seattle are accustomed to use the cubic yard basis, while Atlanta, Boston, Cleveland, Indianapolis, Milwaukee, Philadelphia, St. Louis and San Francisco use the ton. The ton is susceptible of greater accuracy in practical use than the yard, but the objection has been raised that if traveling in an open car subject to rain, the sand might contain a considerable amount of water for which the purchaser would be asked to pay. On the other hand, recent investigations have given prominent publicity to the fact that sand increases in bulk when it becomes moist.

A series of tests have been made by the Stewart Sand Company of Kansas City, Missouri, which determined the actual facts upon which to base a decision as to which is the better unit. These tests seemed to show that sand taken one foot from the surface of a pile contains a minimum of fifty pounds of water to a ton, regardless of how long it has been since rain fell upon it; while it also appears that it never contains more than one hundred pounds to a ton. Therefore the maximum weight added by rain would be less than two and one-half per cent. As a matter of fact, the average loss was found to be thirty pounds per ton or one and one-half per cent.

Investigation of the bulking or swelling of sand showed that when the moisture content was increased from fifty pounds to one hundred pounds the bulk increased at least ten per cent and usually more.

It would appear, therefore, that while heavy rain would not increase the cost of sand more than 2 1-2 percent when it was purchased by weight, it might increase it 10 percent or more when purchased by bulk.

In view of the fact that weight is the more accurate measurement as well as being subject to less overcharge due to moisture content, it would seem to be the preferable unit. This is being recognized by concrete engineers and manufacturers of concrete mixers in that the proportioning of concrete ingredients by weight rather than bulk is coming into practice.

Reinforcement in Concrete Roads

An excellent progress report of the Special Investigation on the Economic Value of Steel Reinforcement in Concrete Roads was presented by C. A. Hogentogler, chairman of that investigation, at a recent meeting of the executive committee of the Highway Research Board of the National Research Council. Mr. Hogentogler expressed appreciation for the splendid cooperation and assistance received in the course of this study from the various state highway departments and other organizations.

The report showed that inspections have been completed on 375 miles of plain and reinforced concrete roads, varying in age from one to ten years, and containing approximately 300 comparisons of slabs with and without steel which were subjected to the same influencing conditions. These roads are located in Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, Georgia, and Ohio. The states still listed for inspection are Michigan, Illinois, Missouri, Wisconsin, Iowa, Utah, Washington, California, Texas, and Mississippi.

It is thus assured that a sufficient number of direct comparisons will be made to warrant drawing definite conclusions regarding the effect of steel as influenced by age, design, traffic, climate, and subgrade, as well as by the type, weight, and placement of the reinforcement itself. Detailed sketches, designs, and tables are being prepared which will give basic comparisons and a summary of results. Maintenance costs of both plain and reinforced concrete roads have also been secured on a large mileage. These costs are in such detail as to show how the maintenance is influenced by any desired variable.

The final report on this investigation will be one of the most complete studies on concrete roads ever undertaken. It will be presented at the Fifth Annual Meeting of the Highway Research Board to be held in Washington, D. C., on December 3 and 4, 1925. As a supplementary feature of this report it is expected to have papers presented by representatives of several states which have compiled special information on plain and reinforced concrete roads. It is planned to devote one of the sessions of the Annual Meeting of the Highway Research Board to the discussion of this report.

Obstructions and Holes in Streets and Roads*

Court decisions concerning Cities' liabilities for damages from unguarded holes and excavations, the necessity for bonus and liabilities of States and Counties.

By John Simpson

UNGUARDED HOLES AND EXCAVATIONS

The Utah Supreme Court holds, Taylor v. Ogden City, 214 Pac. 311, that it was a question for the jury whether the city was negligent in permitting a hole 2 inches deep at one end and 4 to 6 inches deep at the other, and about 1½ feet square in a crosswalk pavement in the heart of the city into which a pedestrian slipped. Whether the city had constructive notice of the defect, and whether the plaintiff was guilty of contributory negligence, were also held questions for the jury.

In Kellerman v. City of New York, 200 N. Y. Supp. 295, it was held that whether the city was negligent in permitting a depression in the roadway 3 to 5 inches deep, 5 to 6 yards long and a foot wide, was a question of fact for the jury.

But the fact that a curbstone was slightly sunken and out of alignment, and a strip of cement had been laid between the sidewalk and the curb, on which a pedestrian fell was held not to justify a finding that the city was negligent. De Pledge v. City of New York, 208 App. Div. 10, 203 N. Y. Supp. 428.

And a village was held not liable for injury to a pedestrian whose toe was caught in the overhang of a hole in a concrete sidewalk 2 to 3 inches deep, 32 inches long and 8 inches wide, throwing her down about 20 feet away, it being common knowledge that concrete walks will sometimes chip and break, if heavy vehicles are backed against them, or heavy substances are dropped upon them, and to hold the city liable because this particular place had not been repaired would place upon it too strict a liability. Kuhn v. Village of East Syracuse, 209 App. Div. 186, 204 N. Y. Supp. 697.

A city is not an insurer of pedestrians. It is not bound to maintain perfection in its sidewalks. The measure of its duty is to maintain its walks in reasonably safe condition. An opening of two inches between a cement sidewalk and a temporary wooden approach, in which a pedestrian caught his heel, was held not a condition making the city liable for negligence. Norman v. Sioux City (Iowa), 197 N. W. 18.

Where the evidence conflicted as to whether a hole in a pavement was 2½ inches deep or 3¼ inches deep, the question whether the hole was only a slight depression or a trap rendering the city liable was held a question for the jury. Gable v. City of Detroit (Mich.), 197 N. W. 369.

Where there was a defect in a city street, an opening in a culvert which had existed for several weeks, into which a pedestrian stepped on a dark night, an instruction that it was the city's duty to keep its streets and culverts in a reasonably safe condition for the use of the public in the ordinary modes for which a street is used was held sufficient, without distinguishing between streets in thickly and thinly populated districts. Clark v. City of South Hutchinson (Kan.), 217 Pac. 305.

On the other hand, where a pedestrian sued for injuries resulting from falling into an excavation made by a municipal corporation in an alley running through some vacant lots, for the purpose of making repairs on its sewer system, the Oklahoma Supreme Court held, Town of Quapaw v. Holden, 222 Pac. 680, that an instruction requiring a municipality to keep its streets and alleys in reasonably safe condition for the use of travelers, whether in the body of the city or near its limits, and that it is as much the duty of the city to keep the streets and alleys in the suburbs of the city in as safe condition for the use of travelers as those in the heart of the city, was erroneous, as it imposed upon the municipality a greater duty than that required by the rule that a municipal corporation is bound to use ordinary care and diligence to keep its streets and sidewalks in a reasonably safe condition for public use in the ordinary mode of traveling.

The rule in Missouri is that a city is only required to exercise ordinary care to see that its streets and sidewalks are kept in a reasonably safe condition, and an instruction defining the duty of a city to exercise ordinary care to keep its sidewalks in a good and safe condition would be erroneous as making the city an insurer. Cooper v. City of Caruthersville (Mo. App.), 264 S. W. 46. And the standard of due care remains the same regardless of the size of the municipality or whether there is much or little travel on the street; but in determining what is due care, all the facts, circumstances and surroundings must be kept in mind, and one of these circumstances is the amount of use to which the street is subjected. Reed v. City of St. Joseph (Mo. App.), 266 S. W. 330.

It was held that a depression in a sidewalk formed by the paving bricks sinking down to varying depths of from 2½ inches to 5 inches, the bricks having become loosened and wavy, some with sharp corners projecting upwards and some missing, in which condition the depression had been for about four weeks, and the city had had actual notice of the defect in time to have repaired it, was such a defect that the city was liable to a pedestrian injured by stepping into the hole when it was covered with snow. Roso v. City of St. Joseph (Mo. App.), 250 S. W. 625.

The same court held a city liable for injuries to a pedestrian by stepping on a part of the sidewalk which was composed of old and rotten material, which would crumble and break when stepped upon. Brigman v. City of St. Joseph (Mo. App.), 251 S. W. 724.

The Virginia Supreme Court of Appeals, in Erle v. City of Norfolk, 123 S. E. 364, held that the evidence did not show that a hole in the con-

(* Continued from page 249)

crete sidewalk, 2 or 3 feet long, 3 to 8 inches wide, and 1½ to 4 inches deep, into which a pedestrian fell, had existed long enough to give the municipality constructive notice of it.

A duty is enjoined upon a municipality to use ordinary care to keep its streets in a reasonably safe condition for travel, whether the dangerous condition is created by the town itself or by others. So the Iowa Supreme Court held, Sparling v. Incorporated Town of Stratford, 191 N. W. 724, that where a pedestrian was injured by falling into a sewer trench dug in a street and left unprotected by barriers or lights for a sufficient time to put the town on notice of its condition, it was for the jury, in an action against the town, the owner of the adjoining lot for whom the trench was dug, and the person who dug the trench, to say which, if any, of the defendants caused or contributed to the injury. The jury found that the duty to properly guard the trench was incumbent on all the defendants. On appeal it was held that the employee of the lot owner, hired by the day to dig the trench, was not liable, and judgment for the plaintiff was reversed as to him and affirmed as to the town and the lot owner.

The contractor for the construction of a bridge engaged to erect barriers, maintain lights, and take all necessary precautionse to safeguard the traveling public, and to assume all risk and liability for damages from construction until the bridge was completed and accepted. Action was brought for the destruction of an automobile by falling into an unguarded excavation left by the contractor in the highway. The bridge not having been accepted, it was held, Mundell v. Board of County Commissioners of Sedgwick County (Kan.), 226 Pac. 757, that the contractor was liable, the excavation being a detail of construction of the bridge, and the backfilling of such an excavation to the original ground surface being made part of the excavation by the contract.

In an action against a construction contractor and a city for death resulting from defendants' failure to properly safeguard an unfinished grade and bridge, because of which deceased fell into an excavation, left without barricade or warning sign, it was held that the fact that deceased was violating a speed limit ordinance would be no defense, unless the injury was the proximate result of the violation. Hyde Const. Co. v. Smith (Okla.), 221 Pac. 34.

NECESSITY FOR BARRIERS

The Michigan statute, Comp. Laws 1915, § 4395 et seq., providing that, when a highway along the bank of a lake, river or other water course becomes, by washing away, etc., reduced to a width of less than 50 feet, the commission shall open such highway to a width of 50 feet or maintain a substantial railing or fence along the edge of the bank, does not apply to a highway in which a ditch or other artificial water course exists. But, outside of the statute, there is the duty to erect and maintain barriers, where necessary, to render a highway reasonably safe and fit for travel.

In an action for death when deceased's horse, frightened by water flowing across the road, plunged into a drain parallel with the highway, it was held, Fidler v. Lafayette Tp. (Mich.), 198 N. W. 262, that if barriers should have been erected and maintained and the horse was frightened by a condition of the highway existing by reason of the township's negligence, and had barriers been there they would have prevented the fatality, then such want of barriers was a proximate cause of the accident and not a secondary or remote cause. If, however, the horse was not frightened by a negligent condition of the highway, then, though barriers would have prevented the fatality, the lack of barriers was not a proximate cause of the accident. Whether water overflowing the highway because of the obstruction of a stream by a bridge, was an extraordinary flood, for which the township would not be liable, was held a question for the jury.

And whether a township was negligent in maintaining a highway 12 to 13 feet wide on a 7-foot fill without a barrier or railing was held a question for the jury in an action by the driver of a wagon which slid off the edge of the traveled way, precipitating team and wagon down the embankment. Carpenter v. Bloomingdale Tp. (Mich.), 198 N. W. 912.

Where a turn at a street intersection by an automobilist was made imperative by the existence of an impassable obstruction maintained in the street by the city and invisible until the automobilist was within 210 feet of the intersection, and he in turning into the other street skidded into a ditch not protected by a guard rail or other protection, the Georgia Court of Appeals held, Mayor, etc., of Milledgeville v. Holloway, 124 S. S. 802, that an inference of negligence of the city was authorized and that such negligence was the proximate cause of injury to the automobilist.

The true test of the necessity for a barrier was said to be in Mayor, etc., of Baltimore v. State (Md. App.), 126 Atl. 130, not whether the dangerous place is outside the highway, or at some little distance therefrom, but whether there is such a risk of a traveler, using ordinary care, in passing along the street, being thrown or falling into the dangerous place, that a railing is necessary.

STATES AND COUNTIES

As a general rule it is held that states and counties are not liable for defects in their highways, in the absence of a statute imposing such liability.

Under section 176 of the New York Highway Law, as amended by section 17 of chapter 371 of the Laws of 1922, the state assumes liability for any defects causing damage to any persons "on such highways as are maintained by the state under such system as the commissioner of highways may adopt pursuant to section 170" of the Highway Law. The New York Court of Claims holds, Treman v. State, 201 N. Y. Supp. 835, that a steam roller, permitted to stand in a highway without any barrier or lights on it in the night time, is such a defect; and the owner of an automobile colliding therewith was held entitled to re-

cover against the state, the driver of the automobile being free from contributory negligence.

In another case claiming damages for death of the driver of an automobile which went over an embankment near a state highway alleged to have been insufficiently guarded by a barrier, the Court of Claims, Wolf v. State, 202 N. Y. Supp. 754, holds that "it must be assumed that when the State, through its legislature, assumed liability for defects in its highways, and used the word 'defects' in its statute, that this language was to receive the same interpretation and construction as had been given to the word 'defect' by judicial interpretation and construction of the act holding towns liable for defects in highways."

The New York Court of Claims holds, French v. State, 198 N. Y. Supp. 878, that, in the absence of a statute, the state would not be liable for any defects of its highways, and it is only because the state has assumed liability of defects that it can be liable for an injury occurring by reason of such defects. The extent of such liability will depend upon the statute as in force at the time of the injury.

Under section 176 of the New York Highway Laws and sections 12 and 26 of the Court of Claims Act the state can only be liable for defects in the highways measured by the same rules of liability as exist between individuals or against municipalities, and for a failure to use ordinary care and reasonable caution in the maintenance and repair of the highways for which it has assumed liability.

"Defects of a trivial character, irregularities, and slight depressions of highways are caused and created by constant use, and it cannot be said that municipalities which are charged with the care of highways are liable for defects of this nature, or liable for a failure to remedy them. The law never intended to cast a burden of this extent upon municipalities in the care of their highways."

Therefore it was held that the existence of several holes, from 3 to 6 inches deep, in a macadam road, which a claimant alleged caused him to lose control of his automobile, resulting in an upset, did not render the state liable for his injuries.

The above quoted statement of opinion that the state cannot be held responsible for trivial defects in state highways was quoted by the same court in Hogan v. State, 199 N. Y. Supp. 275, rejecting a claim by an automobilist for damages for injuries alleged to have been caused by a thin hard layer of earth which had been washed over the concrete curb of a brick roadway maintained by the state. The court was of opinion that the accident was caused by the excessive rate of speed at which the car was driven down hill and not by the slight defect in the highway, which could not be dangerous to traffic in any event. The court said: "It is impossible for the state, with its great system of highways, to promptly remedy every trivial defect in a highway; and defects such as the one under consideration, which could not by any stretch of the imagination become dangerous to any person in any event, except possibly one driving at a high and unreasonable rate of speed, it is not called upon to remedy."

The Arizona Supreme Court held, Larsen v. Yuma County, 225 Pac. 1115, that neither a county nor its board of supervisors and engineer are liable under the Arizona statutes for the death of one killed when the automobile he was driving ran off a bridge into a canal because there was no guard or railing, the county not being liable for the negligence of its officers in the absence of a statute making it liable, and the officers not being liable, because in building and maintaining public highways they were performing governmental functions.

The settled law of Georgia is that a county is not liable to suit unless specially made so by statute. It is not liable for defects in a public road. The statute making it primarily liable "for all injuries caused by * * * defective bridges, whether erected by contractors or county authorities" does not apply to bridges on public roads falling expressly under some other statute, and does not apply to bridges over railroad crossings and their approaches, which are required by statute to be constructed and maintained by the railroads. Hardin v. Southern Ry. Co., 300 Fed. 417.

The Massachusetts Supreme Judicial Court holds, Parker v. Commonwealth, 141 N. E. 495, that the commonwealth was not liable for injuries caused by oil applied to the highway by a truck driver not in the service of the commonwealth, unless the latter had reasonable notice of the defect under Mass. G. L. c. 84, § 15. Whether oiling the highway was a "repair" under the statute, for injury from which the commonwealth would not be liable, the court did not find it necessary to consider.

Copper Sulphate in Drinking Water

During recent years it has been the practice of the water department of New York City to employ continuous automatic treatment of the Catskill supply with copper sulphate during three to six months of the year, the copper being applied to the water as it passes from Ashokan reservoir to Kensico reservoir. The purpose is to prevent seeding the storage reservoir with organisms prevailing in the impounding reservoir, where synura has been present every fall. The dose is generally at the rate of one pound per million gallons.

Efforts have been made to determine how much copper remains in the distribution system of the city, evaporating 1½ gallons for a test, but not a trace was found. Last year 4-liter samples were very carefully analyzed for copper, and the amounts found at shaft No. 23 in Brooklyn were almost exactly those applied in the reservoir. However, copper was found in diminishing quantities for four weeks after the treatment stopped.

Although most of the copper was retained by the water until it reached the consumer, the amount is insignificant and offers no excuse for protests against "dosing the water supply." If a consumer

should drink five glasses daily for eighty years he would receive a total of one-tenth of an ounce of copper, assuming the water to be treated the entire time instead of only one-third the time. Probably few cities use copper treatment more than one-tenth of the time, so that a consumer, in a reasonably long life of water-guzzling, might receive one one-hundredth of an ounce of copper—about one five-hundredth of a cubic inch, or about one particle of copper filings a year.

Blasting a Colorado Snow Drift

In the issue of PUBLIC WORKS for December, 1924, a brief description was given of a plan that had been adopted for blasting out snowdrifts from highways in the Rocky Mountains, the explosive therefor being placed before the snow fell and remaining there throughout the winter. The result of this experiment is described by Roger W. Toll, superintendent of Rocky Mountain Park, as follows:

Last October the National Park Service placed thirteen boxes of dynamite on the Fall River road, in Rocky Mountain Park, at the point where the heaviest snow drift occurs. This point is just east of Fall River Pass, at an elevation of 11,750 feet, 17½ miles from Estes Park. The boxes each contained 50 pounds of 20 per cent dynamite, and were placed 20 to 25 feet apart.

This experiment was conducted at the suggestion of the DuPont company. The dynamite was placed on top of two or three feet of snow, so as to protect the road from injury. The dynamite was connected by a Cordeau Bickford special fuse, consisting of T. N. T. in a small lead pipe. This fuse is waterproof, heavy acting and extremely rapid.

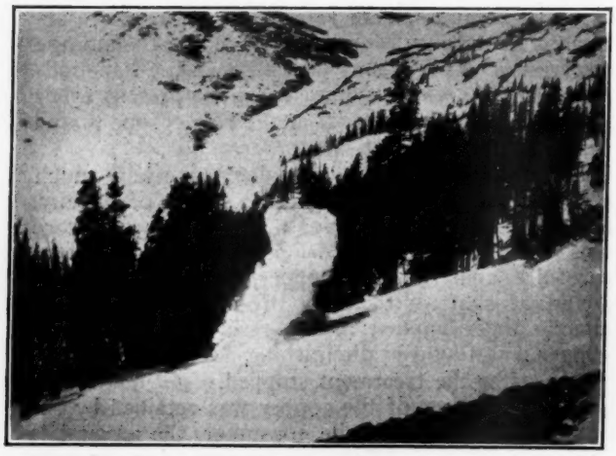
On Sunday, May 24, this charge of 650 pounds of dynamite was fired, and produced very satisfactory results. A trench about 15 or 20 feet wide 300 feet long and about 6 feet average depth was formed in the snow. Approximately 1,000 cubic yards of snow was removed from the road at a cost of six cents per cubic yard. The cost of removal by hand shoveling would have been three or four times this cost.

About one-third of the snow was removed from the 300 feet of road that was "planted." The total drift is about 1,200 feet in length.

The experiment was tried at the deepest drift on the road, when the snow gauge showed a depth of 19 feet. Various methods of using explosives have been tried on this drift, but the plan of placing the dynamite in the fall so as to get it at the bottom of the drift, and leaving it until the work of snow removal begins, is the most effective method that has been tried. A still heavier charge of explosives would have been even more effective.

The National Park service this spring purchased a steam shovel for use on road work, and this shovel early in June was sent to the big drift to finish the job with the idea that if it proved efficient in this work it may supersede the use of explosives and hand shoveling.

The official date for opening the Fall River road to travel is June 15, but visitors found snow banks along the roadside throughout the months of June and July. The snow fall of the past winter was unusually light, and the snow in the mountains is much below normal; but the heaviest drifts, which are mostly formed by wind blown snow, were nearly as deep as usual.



BLAST ON FALL RIVER ROAD, ROCKY MOUNTAIN NATIONAL PARK

Sewer With Low Headroom

By Edward S. Rankin*

A somewhat novel method of sewer construction where lack of headroom prevented the use of a circular pipe was recently adopted in Newark, New Jersey.

In developing a new residence tract, the grading of the streets and laying of the sanitary sewers were done by private contract, but the storm sewer required in one of the streets was constructed under contract by the city. This contract called for 45-inch reinforced concrete pipe. When it came to construction however, it was found that, owing to unfore-

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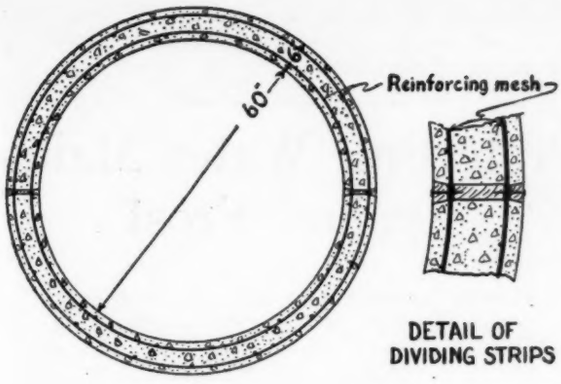
SPLIT PIPE AS DELIVERED WHOLE ON THE JOB.



SECTION OF PIPE SHOWING METHOD OF MAKING.

seen conditions, for a distance of some 400 feet there was not sufficient headroom for a pipe of this size between the top of the house connections already laid and the crown of the street.

To meet this condition, the substitution of two lines of 33-inch pipe or of a reinforced concrete box sewer 2'9"x4' was considered. It was found that either of these would be considerably more expensive than the original plan.

At the suggestion of Francis H. Sherrerd, manager of the Newark Concrete Pipe Company, it was decided to adopt and use 60-inch concrete pipe split longitudinally and laid on a slightly dished concrete invert, the company having offered to furnish the necessary pipe. The proposed construction would have a capacity about equivalent to that of a 45-inch circular sewer, and a 60-inch pipe would cost somewhat less than double the 45-inch, one length of 60-inch pipe making two lengths of sewer. There was, in addition, the cost of the concrete invert which, at the contractor's figure, amounted to $1.70 per foot.

The main point of interest is the method adopted in making the pipe. The regular molds for reinforced concrete pipe were used, but on opposite sides of the pipe between the two rows of reinforcement, and on the inside and outside of each row, were placed strips of wood 2 inches thick. The concrete was then placed and tamped in the usual manner. The full-size pipe were delivered on the job; then the outer and inner strips of wood were removed and the reinforcing wires were cut with pliers. The pipe then readily broke into two semi-circular halves.

SPLIT PIPE AS LAID IN TRENCH.

The half pipes were lowered on to the invert by means of a travelling crane and set in a bed of 1½ inches of cement mortar, the projecting ends of the reinforcing wires forming an excellent bond.

Westmoreland's New Water Supply

Kansas city with water works system but no water for two years. Ground water obtained by well this year.

About ten years ago Westmoreland, Kansas, built a water supply system which consisted of the usual cast-iron mains and fire hydrants and a 50,000-gallon elevated tank. Incidentally the designers of the plant also provided for a 25-foot well from which the supply was to be obtained, but apparently without having investigated as to the possibility of obtaining an adequate supply in this way. This well was dug into a small sand pocket which was filled by drainage from immediately surrounding land. After a short time of operation this supply was exhausted. For two years such a drought has existed that Westmoreland has been practically without any water supply. After this condition had existed for about a year the mayor and council investigated various propositions made to the town for a water supply, especially two, one of which was to build a dam across Rock creek and filter the water so obtained; the other, to obtain a supply from deeper wells. The former was estimated to cost $24,000. The latter was a proposition of the Layne-Western Company, which agreed to guarantee a supply of at least 8,000 gallons a day to continue for one year; to receive for this a sum of $12,325, the entire amount to be refunded in case this amount of water was not supplied for twelve months from the time of completion.

The above facts were stated in a paper before the Kansas Municipalities by C. H. Moore, mayor of Westmoreland, who stated that the latter proposition was accepted because the initial cost was only a little over half, and it was estimated that the maintenance and the upkeep would be lower, while an ample supply of water was absolutely guaranteed. He explained that under the guarantee the contractor agreed to install at least two wells and pumps, and pump foundations, house, pipe line and transmission line to the existing electrical and water lines; also giving a surety bond for the whole amount of the contract price that a minimum quantity of 8,000 gallons a day would be available for a period of one year.

The question was voted upon on January 9, 1925 and carried. The day following, fire destroyed $40,000 worth of property in the town which could

easily have been checked had there been water in the mains.

On Monday, June 8th, the official test of the two wells was made, being measured through a Pittsburgh water meter which registered 30,000 gallons in 24 hours.

In selecting a location for the wells the contractors drilled fifteen test holes in the vicinity of the town and located a gravel bed 6 to 9 feet deep at a depth of forty feet, in the southeast part of the town, and another good bed about 2½ miles from the town. The former site was selected and tests were made to determine the distance required between wells to prevent their affecting each other. Each well was constructed by sinking a 42-inch copperized steel casing carried to the rock which underlies the water-bearing gravel. All the material inside the casing was then taken out with sand buckets and clam-shell buckets. An 8-inch shutter screen was then set in place and the space between this screen and the outer casing was filled with washed and graded gravel. The outer casing was then withdrawn until the bottom was at the upper level of the gravel. The screen was continued with an 8-inch blank casing to a point eight feet above the ground level. A concrete foundation built around the well and carried three feet below the ground level sealed the well against surface water and served as a foundation for the pump. A test of the well showed that when delivering 60,000 gallons a day the water was lowered only three feet.

Increasing Yield of a Deep Well

In 1920 a twelve inch well was sunk for the city of Mt. Clements, Michigan. This well was provided with a medium fine slot Cook strainer. On testing the well, it yielded 350 gallons per minute. After four years of service it was decided to endeavor to increase the yield of the well, and the strainer was removed and made coarser and then returned to position. Following this, a test showed that the well yielded 500 gallons per minute or 40 per cent more than when first installed.

The method of pulling the strainer was described for us by the contractor as follows: The driller removed the pump, working barrel, drop pipe, etc., from the well and lowered a line of pipe having a flange on the bottom, which flange was of such diameter that it would enter the strainer. After the flange had been lowered to the bottom of the strainer, fine sand was poured into the well until the strainer was filled. A pair of wood clamps were then placed around the pipe to which the flange was attached and a pair of jacks placed under them. With this arrangement, a steady pull was exerted on the pipe, raising it and the strainer with it without injury.

The slots of the strainer were made coarse at the factory and the bottom of the strainer or bail plug was taken out. The strainer was then lowered into the well with an open bottom and telescoped or sand bucketed into place—that is, the sand was removed from below the strainer with a sand bucket, allowing it to settle. When the strainer was in position, a plug was set in the bottom to make a sand-tight joint. The operation was then complete except for replacing the pumping equipment.

Protecting Water Mains Against Frost

Boston experiences and methods and those of other New England cities discussed before New England Water Works Association.

The subject of the protection of water pipes and appurtenances in exposed locations was discussed by members of the New England Waterworks Association at a recent meeting, the greater part of the discussion being furnished by George H. Finneran, Superintendent of Water Service of Boston, and Samuel E. Killam, Superintendent of Distribution of the Metropolitan District Commission.

In introducing the subject Mr. Finneran referred to the possibility of damage to water mains by earthquakes, which had been suggested by a recent quake. Where the disturbance of the earth is as great as has occurred several times in California, there would seem to be no precaution that can be taken against the rupture of water mains. In New England, however, little if any damage to mains has been caused by any earthquake which has occurred during recent years. Mr. Finneran, immediately after the earthquake in New England early this year, had not been able to find that any leaks or other damage had resulted therefrom.

Where a water main crosses a waterway or railroad it must be carried either above on a bridge, or below underground or in the bed of a stream. In Boston there are 102 crossings where pipe lines are carried on bridges over railroads or water. Where there are draws in the bridge, the pipe line is carried under the draw-way by means of an inverted syphon enclosed in masonry or wood. When buried in the bed of the stream there is little if any danger by freezing.

Liability to freezing varies with the diameter of the pipe, the minimum velocity of flow, exposure of the pipe to wind, and its position relative to the sun.

From experiences in Boston, Mr. Finneran has reached the following conclusions:

If practicable, all pipes should cross railroads and waterways under and not over. If this is not practicable or for some reason not desirable, pipes of more than 12-inch diameter should be of steel, protected from impact with automobiles or other moving objects, coated to resist acid fumes and liquids, and a velocity of flow should be maintained sufficient to prevent freezing. If the pipes are 12 inches or less they may be of either steel or cast iron, should be adequately supported, the joints strapped to-

gether where there is danger of their pulling apart, and they should be covered with some non-conducting material.

In protecting the pipe, the Boston Waterworks for many years enclosed exposed pipes in double wood boxes, the inside box square and fitted close to the pipe, the outside sheated and with a pitched roof, the air space between the boxes serving as insulation. Where the box was exposed to roadway traffic, a hard pine timber was placed outside as a fender. With the increase in cost of lumber and labor, this type of box became expensive to construct and maintain, boys and malicious men broke the boxes and removed the wood, others sometimes caught fire, and where they were on bridges crossing railroad tracks it was found that blasts from locomotives loosened the flooring and filled the interior of the box with smoke, soot and cinders. The soot carried sulphur which, mixing with water that leaked in, formed an acid which pitted the pipe. For a number of years past, pipes from 18 to 42 inches in diameter have been left entirely uncovered and no indication of ice forming within has been discovered. In all these mains, however, there has been continuous motion of the water.

Where these wooden boxes have deteriorated, they are being replaced by a sheet metal cover over a coating of felt, and the same construction is used in laying new lines of pipe. This construction consists of a covering of felt 3 inches thick wrapped around the pipe. Over this is a layer of tar paper to keep the felt dry, both being kept in place by means of copper wire. Galvanized sheet iron surrounds this, rolled so as to fit snugly over the felt and kept in place by wooden collars 3 inches deep and 2 inches wide, to which the cover is screwed. Along the top is a sheet metal ridge about 1½ inches high to discourage sitting or walking on the pipe. Where the pipe is exposed to vehicular traffic, a 10x10 hard pine fender is placed alongside. Where the pipe goes below the surface of the ground, at each end of the bridge, the metal cover follows it for a few feet. To prevent corrosion of this cover and protect it from blows, a jacket of brick freely coated with cement is placed outside the sheet iron for a distance of two feet above and three feet below the ground surface.

A special treatment was given to a pipe under the sidewalk of a concrete bridge where a space about 20 inches deep and 5 feet wide had been provided for gas and water mains. The entire space was filled with shavings, which material has been used satisfactorily in other places. Cork, though, is better than shavings because it does not absorb moisture.

Where water mains pass over large conduits or subways or for some other reason cannot be sunk more than two or three feet below the surface of the street, an insulating compound consisting of granulated cork mixed with hot pitch has been used with satisfactory results. This practice has been adopted from the cold storage people who use this mixture around their brine pipes to keep them cold. A roughly made form is placed under and on each side of the pipe leaving a space about 6 inches all around, which is filled with a mixture of pitch and cork proportioned six gallons of pitch to two bushels of medium sized granulated cork. In making the mixture, pitch is melted in one kettle and mixed with the cork in a second kettle under which a slow fire is kept burning. While the mixture is fluid it is ladled into the form until the pipe is completely covered. The same mixture is used around water mains where they are near cold storage pipes. The same scheme has been adopted for service pipes where laid near a surface, upon rock, or with a loose stone backfill. For services a 4x4 box is used and filled with hot cork and pitch mixture. Services which formerly froze every winter have given no trouble since this plan was adopted.

Mr. Killam also recommended the use of granular cork and pitch, stating that the Water Division of the Metropolitan District Commission had found it very effective. He referred to its use also for pipes leading to recording gauges and other small pipes in which there is little or no circulation. He stated that the insulating material will remain in good condition for many years with full efficiency, the pitch preventing the cork from decomposing and retaining the dead air in the cork.

Mr. Killam also referred to the use of boxing around an exposed pipe and filling the space with fibrous packing such as oily cotton waste, asbestos, hair felt, mineral wool, tan bark, and the like. Many of these proved absolute failures, as the fibrous materials became saturated with moisture and froze solid. Other materials such as salt hay, rosin, lime, etc., have been used with varying success; but any that tends to decompose will soon become non-effective if not kept dry. Salt hay placed around pipe has generally proved useful where there is considerable moisture, but needs to be renewed every second or third year. Slaked lime has been effective when placed around service pipes or mains containing dead water, such as pipes feeding recording gauges and small mains used for fire purposes only.

Mr. Finneran stated that considerable trouble had been found at points where a line laid on a bridge joined that underground, for while a pipe on a bridge does not settle, the earth behind the bridge abutments is usually filled material and continues to settle, aided by vibration of traffic on the bridge and the railroad traffic underneath. This causes the buried pipe to settle away from the elevated section, pulling open the joints of the connecting lengths of pipe. He recommended that the joints in the pipe connecting the upper and lower levels be strapped together and anchored to the abutment and that concrete piers be placed back of curves and all other precautions possible be taken against leaks or breaks at these points.

He did not believe that large feed lines should be exposed to the risk of crossing bridges. In Boston they are carried under railroads and waterways as inverted steel siphons enclosed in concrete.

Charles W. Sherman referred to a study made many years ago of the proposition to carry a 6-inch

water pipe under the salt water to an island about two miles from the mainland. Due to the fact that the salt water might reach a temperature as low as 27 degrees or even lower, it was thought probable, from calculations made, that even though velocity as high as 5 ft. per second be maintained in the 6-inch pipe which it was proposed to lay, water starting from the mainland at a temperature of 36 or 38 degrees would be chilled to the freezing point inside of ten minutes, while it would require one-half hour for the water to reach the mainland. Here the bottom was such that probably about half the length of the pipe would project above the mud and be exposed to the salt water.

Steven H. Taylor, Superintendent of Waterworks of New Bedford, stated that that city had laid a 2-inch lead pipe in the bottom of a channel 900 ft. wide crossing to an island, but it froze up over winter. Last year the city spent $4,000 and buried a pipe four feet below the bottom and had no trouble from freezing last winter. Mr. Sherman stated that he had looked up all reports on such conditions that he could find and concluded that where a pipe was covered by at least six inches or one foot of mud, freezing was generally prevented; but where the pipe is actually exposed to salt water for any considerable distance it is practically impossible to prevent freezing during cold winters of northern climates.

Sewage Treatment in West Virginia

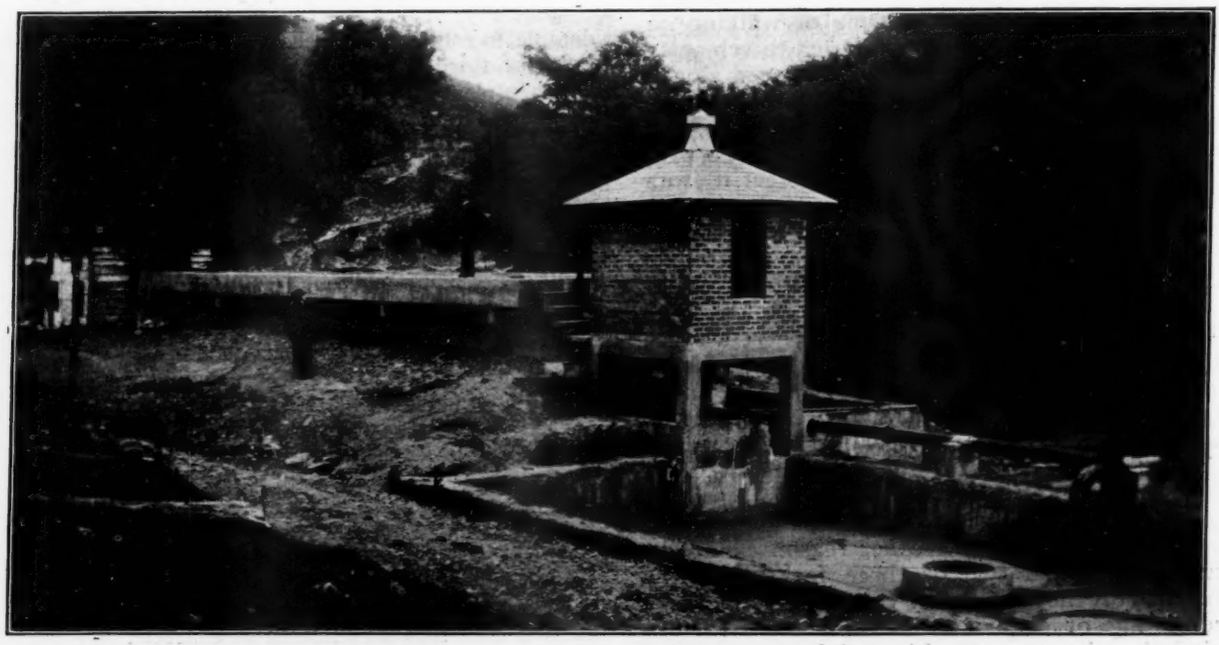
The three plants in this state, the largest treating a half million gallons a day, are well supervised and reports of control tests are made weekly to the State Board of Health.

The following information concerning the sewage treatment plants in West Virginia has been sent to us by E. S. Tisdale, chief engineer of the Department of Health of that State. Mr. Tisdale writes: "The plants are well supervised and reports of operation, giving results of control tests, are made weekly to the State Department of Health."

PLANT AT MARTINSBURG

The largest and one of the most efficient sewage treatment plants in the State of West Virginia is located at Martinsburg. The sewage flow of approximately 500,000 gallons per 24 hours is brought from the city to the sewage treatment plant by a 24-inch trunk sewer about a half mile long. This trunk sewer is constructed on concrete piers for a large portion of the distance, because of the excessive cost of excavation in the limestone formations underlying that section.

The plant occupies about 17 acres along Tuscarora creek on a wide strip of gently sloping bottom land. The sewage goes into a collecting basin with a capacity of 12,000 gallons, is rough screened through parallel bars of one inch spacing, and is then lifted by automatically controlled, electrically driven, centrifugal pumps to an Imhoff tank on the nearby hillside. This



RECENTLY COMPLETED SEWAGE DISPOSAL PLANT AT BLUEFIELD.
Imhoff tank in background, chlorinator house at center, and sludge beds in foreground. The effluent, not completely oxidized, discharges into East river, a small stream flowing by the plant.

SEWAGE PLANT AT MARTINSBURG, W. VA.
Pumping plant in foreground. In background, Imhoff tank, sprinkling filters and secondary settling basins.

Imhoff tank has a detention period in the sedimentation chamber of 2 hours and 50 minutes for a flow of 500,000 gallons of sewage per day. The sludge compartment has a capacity of over six months for 5,000 persons computed at the rate of .007 cubic foot per person per day.

The sewage, after passing through the Imhoff tank, flows into a syphon chamber, from which it is periodically discharged onto a sprinkling filter through 121 stationary spraying nozzles which operate under heads varying from 18 inches to 5½ feet. The filter has an area of about one-third acre and a capacity of 580,000 gallons per day, and is made up of a 6-foot depth of crushed limestone varying in size from 1½ to 3 inches. The filter effluent passes into two secondary settling tanks, rectangular in plan, 50 feet long and 10 feet wide, arranged so that they may be used alternately or simultaneously. The combined capacity of the two tanks is 30,000 gallons of sewage per hour.

At the present time the effluent from the treatment plant is being discharged directly into Tuscarora creek without disinfection, but provision has been made for chlorinating the effluent in the future if deemed necessary.

Two sludge drying beds are provided, each rectangular in plan, 60 feet by 35 feet, and containing coarse sand with an average depth of 21 inches placed over vitrified pipe underdrains surrounded with broken stone.

This sewage treatment plant has been in operation about five years and has given splendid results. The State Department of Health recommended the installation of the plant and has been interested in determining just what results could be obtained in its operation. The large amounts of industrial wastes of varying character occasioned some apprehension regarding the proper functioning of the plant, but daily tests have uniformly revealed a fairly stable effluent. Practically all the suspended solids are removed, but the sewage is usually quite discolored by wastes from the local woolen mills.

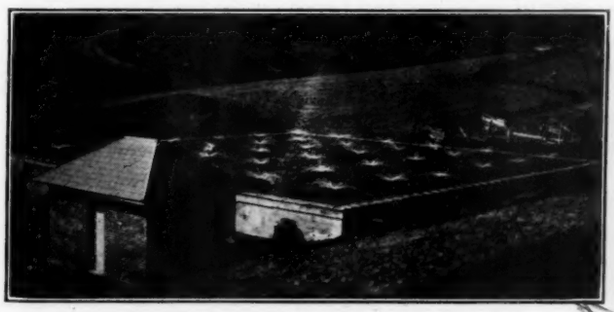
PLANT AT STATE HOSPITAL FOR INSANE AT WESTON, W. VA.

Sewage disposal is provided at this state institution housing 1,200 persons on account of the low flow of the West Fork river into which the sewage ultimately must go. The sewage from the institution is collected at one point where it passes through a screen chamber into a sump. From here automatically operated electrically driven centrifugal pumps lift it through a cast-iron force main 3,530 feet long to a hill back of the institution. Here it enters an Imhoff tank and passes to a siphon chamber, from which it is periodically sprayed onto the adjacent sprinkling filter bed. The sewage coming from the underdrains is chlorinated at a rate of approximately ½ p.p.m. before entering the secondary settling basin. From this basin it flows by gravity directly into the West Fork river below the institution.

PLANT AT BLUEFIELD, W. VA.

Bluefield during 1925 installed a sewage disposal plant for partial treatment of the wastes from 3,000 people from the East End. Approximately 300,000 gallons of sewage is passed through the plant daily.

Treatment consists of passage through an Imhoff tank, where a detention period of approximately 2 hours is given. Effluent from the tank passes down a series of steps where a small degree of aeration is afforded. It is then chlorinated at the rate of 3 pounds of chlorine per million gallons of sewage and the effluent



WESTON STATE HOSPITAL FOR INSANE.
Emptying sludge onto sludge bed from Imhoff tank.

WESTON STATE HOSPITAL FOR INSANE.
Sprinkling filter. Chlorinator house in foreground.

discharged into a nearby small stream, East River.

Sludge disposal is provided by four sludge drying beds which are constructed of coarse rock underlain with drains to the creek.

Filter Well as Cooling Pond

An interesting and ingenious illustration of "killing two birds with one stone" was described by E. J. Rowe, superintendent of the Water and Light Department of Wellsville, N. Y., in a paper in the "Journal of the American Water Works Association." An electric light plant is operated in conjunction with the pumping plant, and a sedimentation basin is used in connection with the water works filtration plant. The sedimentation basin was not covered and on at least three occasions each winter it had been necessary to remove ice from the basin, using four to six men. A condenser was required in connection with steam turbine generating unit from which warm water would be discharged. By passing this warm water through the sedimentation basin, the freezing of the basin would be prevented. The filter plant is operated at a normal rate of 750 gallons a minute, while the amount of cooling water needed for the condenser varies between 500 and 1,000 gallons a minute. A standard type small tube surface condenser was used.

This arrangement was put into service last winter and no ice formed on the basin; while during the previous winter about six feet had been removed. The effect was also shown in the usual freedom from frozen services. Mr. Howe states that the following advantages were obtained:

Improvement in filter operation.

Preventing ice formation in sedimentation basin.

Reduction in number of frozen services.

Control of temperature of condensate from condenser.

Low power requirements.

New California Highway Bridge

A highway bridge over the Van Duzen river, California, has recently been completed which has a total length of 735 feet and a clear roadway width of 21 feet. It is of reinforced concrete and consists of three spans, each 163 feet long, a 30-foot approach span at one end and seven similar spans at the other end. Arch piers and abutments rest on a gravel foundation. The arches are of the barrel or single-rib type with open spandrels in which columns spaced about ten feet apart support the floor slab. The arch rib is two feet thick at the crown and three feet three inches at the springing line. The bridge was designed by the Bridge Department of the California Highway Commission, which selected this type after considerable study and investigation as to the most economical one for this location.

The bridge was designed to carry a concentrated load varying from 70 pounds to 130 per pounds per square foot, depending upon the amount of road occupied. This live load weight was increased for impact over all parts of the structure except the piers and abutments. A temperature variation of 35 degrees rise and fall was provided for. The unit stresses employed were 16,000 pounds per square inch for steel in tension, 650 pounds per square inch for concrete in flexure, 750 pounds per square inch for concrete in compression and flexure when temperature stresses were considered. The concrete was mixed 1:2:4 for all parts of the structure except the piers and abutments, which were of the gravity type for which a 1:3:6 mix was specified. The structure cost approximately $100,000.

Automobile Parking a Fire Hazard

The problem of automobile parking in the business sections of our cities as it affects traffic is recognized as a serious one by every citizen. Its relation to fire fighting is not so generally recognized. "The Parking Hazard as a Fireman Sees It" was the title of a report presented to the International Association of Fire Engineers in which this aspect of the problem was considered.

The chairman of the Providence, R. I., Board of Fire Commissioners is quoted as saying that parking conditions were such in the high fire hazard sections of that city that today it is impossible to reach a blaze in such district as quickly as formerly with the old horse-drawn apparatus, thus rendering unavailing the expenditure of thousands of dollars for time-saving appliances and equipment.

The average man suggests as a remedy parking the cars in the side streets of the district. "From the point of view of the fireman the small street is the vital and strategic point in his battle against man's greatest enemy, fire. The safety of the lives of those in the buildings depends upon the progress to those buildings. Fire escapes, from their very architectural nature, are placed in the rear or at the side of buildings and hence on the small street. Take the parked car out of the small street by all means,

HIGHWAY BRIDGE OVER VAN DUZEN RIVER, CALIFORNIA

says the fireman, that I may successfully guard your life and property."

This seems to necessitate keeping parked cars off the streets entirely, and to this committee public garages seem to be the only solution. Such garages "should be fireproof with complete sprinkler systems. They may be made with a number of floors, with elevators and runways to suit the demands of their several capacities. Checking systems with classifications according to the time of stopping would provide for the short-time and the long-time parking."

Filters for Chicago's Water Supply

Preliminary plans for plants projecting into the lake, drawing raw water from and discharging filtered water into existing tunnels.

The quantity of Chicago's water supply has been giving the officials and some of the citizens much concern for some years past, but little has been said or seemingly thought about the quality of it. In an official report to the commissioner of public works a few weeks ago by John Ericson, city engineer, to which he gave the title "The Quality Problem in Relation to Chicago's Water Supply," he made some definite recommendations for immediate action looking to early filtration.

Previous to 1916 hypochlorite plants had been operated more or less intermittently at the 68th Street and Lake View cribs, but the results were quite unsatisfactory. Since that date liquid chlorine plants have been installed at the various pumping stations and used very effectively; but owing to increasingly unsatisfactory condition of the raw water the chlorine doses have been increased until objectionable taste has occurred. In 1923 about 673,000 pounds of chlorine was used and in 1924 about 1,250,890 pounds. The chief sanitary engineer of the Health Department of Chicago, Arthur E. Gorman, has said that "the increasing quantities of chlorine required for disinfecting the water will render it quite objectionable for drinking purposes." Mr. Ericson says that "the effect of moist free chlorine on metals is very destructive, and it seems to be only a question of time when the large quantities prescribed will make the maintenance and up-keep of our machinery a very serious matter."

In 1924 Loran D. Gayton, engineer of water works design of the Bureau of Engineering, was asked to report on the subject of filtering the supply, which he did in January, 1925. He pointed out that the properties that would be necessary for filtration plants, if located at the various pumping stations, in several instances have been covered with costly buildings and the property values have increased to such an extent that even now to secure the necessary rather extensive land areas for filtration plants adjacent to the stations is almost beyond the financial reach of the department, and this will be more so as time goes on. Apparently the only alternative would be to consider the location of filter plants at or adjacent to the present or projected lake shore, in practical reach of the trunk tunnels supplying the various districts and where these tunnels pass from lake to shore sections.

Preliminary plans have been prepared adopting this alternative, and are described by Mr. Ericson, from which description we have prepared the following abstract.

There are five main groups of tunnels leading from the cribs inland and then branching out to the various pumping stations. It is proposed to install a plant to serve each group of tunnels. They will vary somewhat according to the different conditions. The plan described is especially adapted to the Wilson Avenue and 73rd Street locations.

The plan follows those of the more successful plants in service, and careful studies were made of such plants, especially of those treating Lake Michigan water.

It is intended that a plant be placed at the shore as near to each water supply tunnel group as is practicable. The low-lift pumping station will draw the raw lake water from a suction well or shaft connected to the tunnel delivering it to a raw water chamber, where it will undergo a treatment with chemicals, and then flow to the several parts in the plant, including the filters proper; then by gravity to a storage reservoir underneath the upper structure, from which as clear, filtered water it will return through a shaft or pit into the tunnel system supplying various service pumping stations.

Ample space has been provided in the structure for both receiving and storing various materials and chemicals necessary, which can be most conveniently delivered by water.

Mixing and supplying the chemicals to the raw water are accomplished in the head house located immediately over the low lift pumping plant. Overhead in the towers at the shore end are also placed the washwater tanks. At the other end of the filtration buildings is located the chemical and testing laboratory.

The chemicals used after being mixed flow through pipes to the mixing channel containing the raw lake water, where by an arrangement of baffles in the flow channels, they are still more thoroughly mixed with the water. By a submerged gateway the water flows into the coagulation basins, designed to give a settling period of about three hours. From this basin it flows over a long crested weir as a shallow, wide stream, skimming the surface layer water at this point, and thence into the supply channels between the filter basins, which are elevated somewhat above the filter basins in order to provide a head on to the filters.

The filter basins are arranged in two sections or separate buildings and have inter-communications. In each building the filter basins are arranged in two rows, 20 units in each row, 40 in each building, or 80 units in all. Each filter unit is practically square and has an aera of 1,088 sq. ft. and a capacity of 4 m. g. d. The water passes out of the filter through a pipe chamber down into the clear or filtered water reservoir underneath the filter units. Rate controllers are located in the pipe chamber and

directly connected with recording apparatus located in the operating table. The clear or filtered water storage reservoir is located under the filters and extends the entire length of the pier.

Six motor-driven centrifugal pumps would be installed, four each with a capacity of 100 m. g. d., being driven by synchronous motors, while two pumps with a capacity of 50 m. g. d. would be driven by slip-ring motors, in order to vary the pumpage so as to keep a constant head or level in the filter basins. These pumps would probably operate against a head of about 35 feet. The clear and wash water pumps would also be installed in this room.

The low lift pumps would deliver the raw water into the mixing chambers, where the chemicals from the overhead tanks would be added.

The filtered water reservoir is placed directly under the filters and extends beyond as far as necessary. It has to be made of such a capacity that the low lift pumps and filters could operate at a uniform rate and the reservoir take care of the peak loads and fluctuations. A study of the variations in demand per hour, day, month, and year over a period will be made before deciding upon the final capacity of this reservoir.

Because of the necessity of extending this reservoir beyond the filters proper there is extra overhead space available, and it is proposed to use this for recreation features.

The filtered water would flow by gravity into the tunnel and to the distributing pumping stations.

The principal difficulties to be met with in the location and construction of the filter plants proposed are:

Firstly, the connecting up of the filter plant to the existing tunnels and the separation of the raw from the filtered water sections of the tunnels. Where there are several tunnels in a group connected up with each other, and especially after the pumpage shall have been materially reduced by metering of the system, this problem will be considerably simplified. With filter plants in connection with new tunnels there will be no such construction difficulties.

Secondly, Objections may be raised to the location of filter plants remote from a pumping station on account of the filtered water becoming again polluted by seepage into the tunnel between the filter plant and the pumping station. There are now cases where water shows pollution by seepage into the tunnels, but this is undoubtedly due principally to seepage at and through the land shafts, especially where sewers are adjacent thereto. There would be a thorough investigation of such matters in connection with each group of tunnels before a final decision as regards filter plants would be made.

The mechanical and architectural details of the plant described were worked out by Alfred H. Marshall and Leif H. Bergsund, engineers in the Designing Division of the Bureau of Engineering, under Mr. Gayton's immediate direction and the general supervision of Mr. Ericson.

The estimated cost of one of these typical plants of 300 m. g. d. capacity is from $7,000,000 to $8,000,000.

With the presentation of the foregoing report, since an undertaking of this magnitude requires a long time in preliminary studies and in execution of plans, Mr. Ericson made the following recommendations:

"First—That an ordinance for the universal metering of the Chicago water supply, as a necessary prerequisite to filtration, be introduced and passed at the earliest possible date.

"Second—That an appropriation of $100,000 be requested for the preparation of plans and the construction of one or possibly two temporary experimental plants to be constructed, the first at the 68th Street pumping station on grounds adjacent to the station and owned by the City, and a second one, if needed, on the North Side at Lake View pumping station. Such a plant should be operated for at least one year or longer before final designs are made for permanent plants.

"Third—That a thorough examination be made of each group of tunnels to discover sources of pollution, if any, through seepage, and where such pollution is discovered that every effort be made to eliminate the same.

"Fourth—That negotiations be entered into with the Lincoln Park and South Parks Board of Commissioners with a view of reserving such lands as may be required for filter plants, and the protection of such lands from encroachments.

"Fifth—That in the meantime a continued study be made and required information obtained for the most up-to-date and final designs of water purification plants for the City of Chicago."

Refuse Disposal and Street Cleaning in Baltimore

Salvaging and incinerating plant now in operation and others to be built. Motor flushers found effective.

In his recent message to the City Council, the mayor of Baltimore, Md., summarized the present conditions as to refuse disposal in that city as follows:

"A ten-year contract for the disposal of garbage had been made with the Sanitary Reduction Company shortly before this administration assumed office, but all refuse other than garbage was still being dumped into the most convenient area of low ground. Constant complaint was being received of the odors and smoke from dump fires, and the chief engineer was directed to investigate and make recommendations as to the best method of refuse disposal. A careful study was made of the practice in other cities, and it was determined that a combined salvaging and incinerating plant, such as was in operation in Washington, D. C., would be most suitable for that purpose.

"One such plant, disposing of 1,000 cubic yards or 100 tons of rubbish daily, has been built at the northwest corner of 28th and Sisson streets, on the margin of the old quarry hole which the Street

Cleaning Department has been using as a dump. This plant, which cost approximately $116,000, was put in operation on November 25, 1924, and is capable of disposing of approximately 25 per cent of the city's accumulation, making reasonable allowance for future growth. An appropriation of $300,000 was provided in 1924, and an additional appropriation of $200,000 in the 1925 budget, which is estimated to be sufficient to provide plants for the disposal of all rubbish from the entire city. It is expected that the value of salvage, such as paper, rags, tin cans, bottles, scrap metal, rubber, broken glass, etc. will substantially exceed the cost of operating these plants and will pay a considerable part of the cost of collecting the refuse."

From Nov. 25th to the end of the year approximately 6,000 cubic yards of rubbish was disposed of and from this the salvage included 234,633 pounds of paper, 11,901 pounds of rags, 43,928 pounds of tin cans, 3,500 pounds of old shoes, rubber, etc., 12,000 pounds of metal, 15,000 pounds of broken glass and 12,000 bottles.

During 1924 a total of 49,746 tons of garbage was collected and 527,895 cubic yards of ashes by the Street Cleaning and Sanitary Division of the department. A total of 44,220 cubic yards of market refuse was removed, 179,910 cubic yards of street dirt, 59,414 cubic yards of snow and ice, and 42,109 dead animals.

The annual report for 1924 made to the Mayor and City Council by Commissioner Larkins also gives details of the work performed during the year by the Mosquito Division of this department. Almost 1,000,000 lineal feet of ditches were cleaned during the year; new ditches constructed totaled 11,495 lineal feet, and 6,719 gallons of larvacide solution, 10,001 gallons of plain oil and 418 gallons of pure larvacide were used.

The total appropriation for this department in 1924, including increments, was $1,667,620.21. The total expenditures for the year was $1,537,289.32, as follows: Salaries, $58,360.14; incidental expenses, $4,977.74; street cars and men, $159,017.42; sweepers, $363,117.45; tools and repairs, $5,457.39; collection of garbage, ashes and rubbish, $587,825.81; removal of garbage (including contract for disposal), $150,607.04; removal of ashes and rubbish, $26,875.25; flushing machines, $12,054.48; new equipment, $86,198.86; market cleaning, $52,794.24 and extermination of mosquitoes, $30,003.50.

In addition to Commissioner Larkins the personnel of the department includes Edward F. Callahan, Deputy Commissioner; William A. Larkins, Jr., secretary; Bart L. Malooly, principal account clerk, and Burdett F. Keenan, senior clerk.

During the year three five-ton motor flushers, of 1,500 gallons capacity each, were added to the equipment of the department, bringing the total number of these machines in use in 1924 up to four. They were used to flush the downtown streets every night and also were used on a number of other heavily traveled thoroughfares. Commissioner Larkins said that these flushing machines are very effective in ridding the streets of fine dust. In his appropriation for the present year money for the purchase of three more of the machines was allowed.

"Four five-ton Mack chassis were purchased in October, which were equipped with large rubbish bodies in the department's own shop. These trucks are used in connection with the incinerating plant, collecting and relaying rubbish.

"Five five-ton White dump trucks were secured in June for the collection of garbage and street dirt and the relaying of garbage from the outlying sections.

"Two new scows were bought for removal of garbage to the disposal site. The department now has seven scows for removal of garbage and five for removal of ashes.

"Forty new horses were purchased to replace those unfit for service.

"The district foremen of Street Cleaning were furnished with Ford roadsters in order to give closer supervision to their work, and a resulting improvement has been noticed.

"The street sweepers were again uniformed in white after an absence of about five years without uniforms of any kind.

"All work in connection with the payroll and paying off of employees of the department was assumed by the Central Payroll Bureau on December 1st, 1924."

Fundamental Features of Garbage Furnaces

That should be incorporated in the design if satisfactory service is to be obtainable, in the opinion of J. S. Osborn.

At the January meeting of the Sanitary Engineering Division of the American Society of Civil Engineers Samuel A. Greeley presented a paper on the subject of the "Elimination of Odors from Garbage Disposal Works." In a discussion of this which is published in the August issue of the "Proceedings" of that society, I. S. Osborn, vice-president of the C. O. Bartlett & Snow Co., describes as follows some of the fundamental features that should be incorporated in furnace design to give satisfactory service:

"Temperature.—The furnace should be designed so that a uniform temperature can be maintained when burning material with low heat value and high percentage of moisture, with assurance of temperature at all times sufficient to obtain complete combustion or oxidation without part of the gases passing off by distillation.

"Fuel.—The design should be such that material containing a small quantity of combustible matter and a high percentage of moisture will burn without using additional fuel. This can be accomplished only by utilizing at maximum efficiency the heat developed in its operation.

"Maintenance.—The cost of the maintenance of furnaces will depend on their design and the incor-

poration of features calculated to give proper protection under severe service. The design should permit of performing maintenance work without disturbing other parts of the furnace not in need of such work.

"*Thermal Efficiency.*—The design should be such that the thermal efficiency will be high, using materials and construction that will insure only a small loss from radiation, with temperature developed to a maximum.

"*Draft.*—The design should insure that all parts of the furnace can be balanced as to draft, including the furnace chamber, combustion chamber flues, and chimney.

"*Simplicity.*—A furnace for burning refuse adapted to the service for which it is intended, as well as the class of labor to be employed, and the material to be burned, should be simple in design.

"*Combustion.*—Furnaces to insure proper combustion, should have:

(*a*) Ample space for combustion and the burning of material carrying a large quantity of hydrocarbon.

(*b*) Maintenance of steady high temperature in the fuel bed and in different parts of the furnace chamber.

(*c*) An adequate air supply, thoroughly distributed at the point where combustion takes place.

(*d*) Charging of the furnace and the manipulation of the fire without opening the fire doors or charging doors.

(*e*) The maintenance of a fuel bed on the grate whereby a variable quality of material will not influence the combustion or cause fluctuation in temperature.

(*f*) A high rate of combustion for maintenance of temperature and satisfactory operation.

"*Pre-Heating Forced Draft.*—The pre-heating of forced draft air aids in combustion by supplying heat, thus permitting the burning of a lower grade of material; and, due to the expansion of the air in pre-heating, it permits of better distribution and, at the same time, reduces the excess air that would be required if it were not heated.

"*Structure.*—To withstand the continued heating and cooling of the furnace, as well as to take care of the stresses developed under high temperature, the furnace should be designed as a structural unit with all the stresses that are developed in it taken up by the structural parts, the brick housing being installed for refractory and insulating purposes.

"The author presents a table of analysis of organic garbage with the estimated quantity of coal that would be required to supply fuel and maintain a temperature of 1,240° Fahr. At this temperature, all gases or combustible materials will oxidize and be destroyed without producing odor.

"A furnace, however, operating under variable conditions, such as charging and cleaning, will not hold a uniform temperature. The usual practice in high temperature furnaces is to maintain a temperature higher than is ordinarily required in the combustion chamber so as to insure that the minimum temperature will be sufficiently high to guarantee complete combustion.

"The burning of mixed refuse in incinerators will insure better results than the burning of wet organic waste, which requires a large quantity of additional fuel. It should never be necessary for any city to burn only organic wastes (kitchen garbage).

"With a mixed collection of rubbish and garbage disposed of by incineration, in furnaces which consume the mixture at high temperature, the odors, with proper treatment in collection, storage, or combustion, will be prevented.

"Investigation of plants burning organic waste (kitchen garbage) and using large quantities of additional fuel will show that there is a tendency to economize on fuel at the expense of operating with odors due to incomplete combustion."

Sewage Treatment in New York

Plans have been approved by the Board of Estimate and Apportionment of New York City for disposing of the sewage of the Fourth Ward of the Borough of Queens, which it is estimated will have a population of 725,000 in 1960. As the effluent will flow into Jamaica Bay, the sewage will eventually require a high degree of purification, probably by the activated sludge process. The first installation, approved a few weeks ago, will consist of a grit chamber and a fine screening and pumping plant, with a capacity to handle twice the dry weather flow of thirty million gallons a day which is expected within ten years. The contract price for the grit chamber is $108,600 and that for the fine screening and pumping plant is $1,047,500. This plant will replace the obsolete Jamaica disposal plant. To provide for future extensions, proceedings have been instituted to acquire title to six blocks of adjacent territory. The contract has been awarded at $44 per lineal foot for constructing a temporary 51-inch wood stave pipe, 5100 ft. long from the plant to the mouth of Bergen creek.

In the Borough of Richmond a fine screening plant was finally authorized on May 15th, the object of which is the protection of a bathing beach. This plant will comprise two screens each with a capacity of five and one-half million gallons a day, a chlorinating apparatus and two centrifugal pumps with a combined capacity of six million gallons a day. The screens will probably be of the Reinsch-Wurl, Tark or Dorrco type. The cost is estimated at $120,000. The effluent will be discharged about 2400 feet off-shore from the present high water line.

Sewage Treatment in Helena

The City of Helena, Montana is sewered with two distinct systems of sanitary sewers, one on each side of the town. That on the east side discharges through a 12-inch outfall sewer and that on the west side through a 24-inch. When the system was constructed in 1888 the city purchased a 246 acre farm about 1 mile east of the city limits, and used this as an irrigation farm for the east side sewage. The sewage from the west side system was given to a large ranch owner near the city in return for right-of-way concessions for the sewer ditch. The east side

sewage flows in an open ditch at approximately a 2% grade for about a half mile before reaching the farm, the velocity in the ditch being such that it is necessary to keep the bottom paved with either cobble stones or planks to prevent scouring. Probably owing to this velocity, the sewage on reaching the farm contains no solid matter, all of it having been disintegrated. The sewage is distributed on the farm by ordinary irrigation methods. The farm is rented for $340 a year, although the city has received as much as $1000 per year in the past. The health regulations prohibit the user from raising any garden truck on the farm, but hay and small grains are grown and the renter conducts a small dairy. He states that for some reason which he cannot explain, the cows prefer to drink the sewage rather than the good well water that he provides for them.

The west side sewage was given to a large ranch owner, who used it for some years on his ranch, but this has now been split up into smaller tracts and the sewage is divided among the tenants for irrigation. This sewage also flows in an open ditch of steep grade and no trouble has ever been experienced with solid matters or with settling in the ditch. In both systems the users keep the ditch in repair from the outfall of the sewer to their farms.

As Troy Carmichael, city engineer of Helena, (to whom we are indebted for this information) remarks in his letter: "Very few cities have such ideal conditions provided for them by Nature."

Sewage Treatment Plants in the United States

Lists of plants in the several states, with information as to their type, size and other details, furnished to Public Works by the engineers or other officials of the State Boards of Health. Continued from the July issue. Lists from additional states will be published next month.

New Jersey Municipal Sewage Treatment Plants

Information furnished by H. P. Croft, Chief Engineer, State Department of Health.

Location	Owner	Treating Sewage from	Type of Plant	Gallons Treated per Day	Effluent Discharged into
Allenhurst	Municipality	Allenhurst	Sedimentation	483,000 (max.)	Atlantic Ocean
Asbury Park.....	Municipality	Asbury Park	Sedimentation	1,800,000 (max.)	Atlantic Ocean
Atlantic City.....	Municipality	Chelsea Hts. Section	Mechanical screening and liquid chlorine disinfection	.....	Beach Thorofare
Atlantic City (City Island Plant)....	Atlantic City Sewerage Co.	Atlantic City	Screening	.....	Beach Thorofare
Atlantic City.....	Atlantic City Sewerage Co.	McKinley Ave. Section	Screening and liquid chlorine disinfection	.....	Beach Thorofare
Atlantic City.....	Atlantic City Sewerage Co.	Raleigh Ave. Section	Screening and liquid chlorine disinfection	.....	Inside Thorofare
Atlantic City.....	Atlantic City Sewerage Co.	Texas Ave. Section	Sedimentation and hypochlorite disinfection	.....	Beach Thorofare
Audubon	Municipality	Audubon	Sedimentation, sprinkling filters and secondary sedimentation	.....	Newton Creek
Avalon	Municipality	Avalon	Sedimentation	.....	Townsend's Inlet
Avon	Municipality	Avon	Sedimentation	275,000 (max.)	Atlantic Ocean
Bay Head.....	Municipality	Bay Head	Sedimentation	250,000 (max.)	Sunset Lake to Barnegat Bay
Beach Haven.....	Municipality	Beach Haven	Sedimentation	200,000 (max.)	Atlantic Ocean
Belmar	Municipality	Belmar	Sedimentation	1,300,000 (max.)	Atlantic Ocean
Bergenfield	Bergenfield-Dumont	Bergenfield & Dumont	Screening, settling tanks, dosing tanks and intermittent sand filtration	.....	Trib. to Hackensack River
Beverly	Municipality	Beverly	Sedimentation	.....	Delaware River
Bogota	Municipality	Bogota	Sedimentation	.....	Hackensack River
Boonton ..... (Jersey City Rockaway Valley Trunk Sewer)	Jersey City	Dover, Wharton Rockaway & Boonton	Sedimentation, separate sludge digestion, contact beds, sand filtration and chlorination (glass covered sludge beds)	.....	Rockaway River
Bordentown	Municipality	Bordentown	Sedimentation, contact beds and filtration	.....	Black Creek, trib. to Delaware River
Bradley Beach..... (2 plants)	Municipality	Bradley Beach	Sedimentation	600,000	Atlantic Ocean
Bridgeton ..... (2 plants)	Municipality	Bridgeton	Sedimentation and disinfection	.....	Cohansey Creek
Brooklawn	Municipality	Brooklawn	Sedimentation	70,000	Delaware River
Burlington	Municipality	Burlington	Sedimentation and intermittent sand filtration	.....	City ditch, trib. to Delaware River
Butler	Municipality	Butler-Bloomingdale	Sedimentation and intermittent sand filtration and chlorine disinfection	.....	Pequannock River

New Jersey Municipal Sewage Treatment Plants—Continued

Location	Owner	Treating Sewage from	Type of Plant	Gallons Treated per Day	Effluent Discharged into
Cape May Court House	Municipality	Cape May Court House	Sedimentation and subsurface irrigation	3,000	Lubbus Run, trib. to Delaware Bay
Cape May Point...	Municipality	Cape May Point	Broad irrigation	.....	Delaware Bay
Carlstadt	Municipality	Carlstadt	Sedimentation	.....	Berry's Creek
Cliffside Park.....	Municipality	Cliffside Park	Imhoff tank	.....	Hudson River
Collingswood	Municipality	Collingswood	Sedimentation, contact beds and separate sludge digestion	.....	Newton Creek
Deal	Municipality	Deal	Sedimentation	84,000	Atlantic Ocean
East Rutherford...	Municipality	East Rutherford	Sedimentation	.....	Berry's Creek
Egg Harbor.....	Municipality	Egg Harbor	Imhoff tanks and sand filters	.....	Mullica River
Englewood	Englewood Sewerage Co.	Englewood	Sedimentation	.....	Overpeck River
Essex Fells.....	Municipality	Essex Fells	Sedimentation and intermittent sand filtration	.....	Caldwell Brook
Fairview ..... (Bergen County)	Municipality	Fairview	Sedimentation and contact beds	.....	Hackensack River
Fairview ..... (Camden County)	City of Camden	Fairview section of Camden	Sedimentation	400,000	Trib. to Delaware River
Flemington	Municipality	Flemington	Sedimentation and Intermittent sand filtration	.....	North Branch of Raritan River
Freehold	Municipality	Freehold	Sedimentation and intermittent sand filtration	.....	Trib. of Manasquan River
Freehold	Municipality	Texas section of Freehold	Tank effluent to Freehold fields	.....	
Glassboro	Municipality	Glassboro	Sedimentation, oxidation and (under construction) chlorination	.....	Chestnut Branch of Mantua Creek
Hackensack ..... (2 plants)	Municipality	Hackensack	Flotation basins and Imhoff tanks	.....	Hackensack River
Haddonfield	Municipality	Haddonfield	Imhoff tanks, sprinkling filters and secondary sedimentation	.....	Coopers Creek
Haddonfield	Haddonfield-Haddon Twp.	Haddonfield and Haddon Twp.	Imhoff tanks, sprinkling filters and secondary sedimentation	.....	Newton Creek
Haddon Heights...	Municipality	Haddon Hts.	Sedimentation, sand filtration and hypochlorite disinfection	.....	Trib. to Newton Creek
Haddon Twp.	Municipality	Bettlewood sec of Haddon Twp.	Clarification tank, sludge digestion, sprinkling filters and secondary sedimentation	.....	Newton Lake
Haddon Twp.	Municipality	West Collingswood sec. of Haddon Twp.	Sedimentation & separate sludge digestion	.....	Newton Creek
Haddon Twp.	Municipality	Westmont sec. of Haddon Twp.	Imhoff tank and sprinkling filters	.....	Cooper's Creek
Haddon Twp.....	Municipality	Westmont section of Haddon Twp.	Settling tank, sludge digestion, with provision for secondary sedimentation	.....	Cooper's Creek
Hammonton	Municipality	Hammonton	Imhoff tank, sprinkling filters and secondary sedimentation	840,000	.....
Hasbrouck Hts. ..	Municipality	Hasbrouck Hts.	Screening, sedimentation, sprinkling filters and secondary sedimentation	.....	.....
Haworth	Municipality	Haworth	Sedimentation and sub-surface irrigation	.....	.....
Hightstown	Municipality	Hightstown	Sedimentation and intermittent sand filtration	.....	Millstone River
Interlaken	Municipality	Interlaken	Sedimentation	.....	Loch Arbor Sewer System
Island Heights.....	Municipality	Island Heights	Screening and intermittent sand filtration	.....	Trib. to Toms River
Island Heights	Municipality	Island Heights	Sedimentation & sand filtration	.....	Toms River
Keansburg	Municipality	Keansburg	Mechanical screening	.....	Raritan Bay
Keyport	Municipality	Keyport	Sedimentation and hypochlorite disinfection	.....	Raritan Bay
Lakehurst	Lakehurst Sewer Co.	Lakehurst	Sedimentation and intermittent sand filtration	.....	West Branch
Leonia	Municipality	Leonia	Imhoff tanks	.....	Overpeck Creek
Little Falls	Municipality	Little Falls	Sedimentation and intermittent sand filtration	.....	Passaic River
Little Ferry	Municipality	Little Ferry	Sedimentation	.....	Hackensack River
Loch Arbor	Municipality	Loch Arbor	Sedimentation	100,000	Atlantic Ocean
Long Branch	Long Branch Sewer Co.	Long Branch	Screening	230,000	Atlantic Ocean

New Jersey Municipal Sewage Treatment Plants—Continued

Location	Owner	Treating Sewage from	Type of Plant	Gallons Treated per Day	Effluent Discharged into
Long Branch	Municipality	Branchport section of Long Branch	Sedimentation	20,000	Branchport Creek
Long Branch	Municipality	North Section of Long Branch	Sedimentation	60,000	Manhassett Creek
Longport ..... (2 plants)	Municipality	Longport	Sedimentation and hypo disinfection	.....	.....
Lyndhurst	Municipality	Lyndhurst	Imhoff tank, grit and screen chamber and sludge drying bed	.....	Trib. to Hackensack River
Macopin	Newark	Macopin	Sedimentation and intermittent sand filtration	8,000	Pepuannock River
Manasquan	Municipality	Manasquan	Sedimentation	350,000 (max.)	Atlantic Ocean
Margate City ..... (2 plants)	Municipality	Margate City	Sedimentation and hypo disinfection	.....	Beach Thorofare
Matawan	Municipality	Matawan	Sedimentation and liquid chlorine disinfection	.....	Matawan Creek
Maywood	Municipality	Maywood, part of North Hackensack	Imhoff tanks	.....	Hackensack River
Medford .....Medford Sewer Co.		Medford	Sedimentation and sand filtration	.....	Haynes Creek
Merchantville	Merchantville-Pensauken Twp.	Merchantville & Pensauken Twp.	Sedimentation, mechanical sludge removal and separate sludge digestion	.....	Cooper's Creek
Metuchen	Municipality	Metuchen	Imhoff tank and intermittent sand filtration	.....	Trib. to Raritan River
Middlesex Boro	Plainfield, N. Plainfield, & Dunellen	Plainfield, N. Plainfield & Dunellen	Mechanical screening, sedimentation, sprinkling filters and secondary sedimentation	.....	Green Brook
Millville	Municipality	Millville	Sedimentation and liquid chlorine disinfection	.....	Maurice River
Moorestown	Municipality	Moorestown	Imhoff tank, sprinkling filters and secondary sedimentation	.....	Pensauken Creek
Morristown	Municipality	Morristown	Sedimentation, contact beds, intermittent sand filtration and chlorine disinfection	.....	Whippany River
Neptune Twp.....	Municipality	Neptune Twp.	Sedimentation	400,000	Atlantic Ocean
Newton ..... (2 plants)	Municipality	Newton	Sedimentation and intermittent sand filtration	220,000	Paulins Kill
North Arlington ...	Municipality	North Arlington	Imhoff tank	.....	.....
North Bergen ..... (3 plants)	Municipality	North Bergen	Sedimentation	.....	.....
Oaklyn	Municipality	Oaklyn	Imhoff tank, sprinkling filter and secondary sedimentation	.....	Peters Brook
Ocean City	Ocean City Sewer Company	Ocean City	Sedimentation and hypochlorite disinfection	.....	Beach Thorofare (Great Egg Harbor Bay)
Ocean Grove ..... (2 plants)	Ocean Grove Camp Meeting Assoc.	Ocean Grove	Sedimentation	1,800,000	Atlantic Ocean
Oradell	Municipality	Oradell New Milford	Sedimentation	.....	Hackensack River
Palisades Park....	Municipality	Palisades Park	Imhoff tank	.....	Hackensack River
Palmyra	Municipality	Palmyra	Clarification tanks and separate sludge digestion	.....	Delaware River
Paulsboro	Municipality	Paulsboro	Imhoff	.....	Mantua Creek
Pemberton	Pemberton Twp. Water, Sewage & Light Co.	Pemberton	Broad Irrigation	.....	Trib. to Arthur Kill
Perth Amboy	Municipality	Lehigh Park Section of Perth Amboy	Sedimentation	.....	Trib. to Raritan River
Perth Amboy	Municipality	Kennedale Park Section of Perth Amboy	Sedimentation	.....	Delaware River
Pitman ..... (2 plants)	Municipality	Pitman	Imhoff tanks, sprinkling filters and secondary sedimentation	.....	Chestnut Creek
Pleasantville	Municipality	Pleasantville	Mechanical Screening	.....	Beach Thorofare
Point Pleasant	Municipality	Point Pleasant	Sedimentation	400,000 (max.)	Atlantic Ocean
Princeton ..... (Northeast Plant)	Municipality	Princeton	Imhoff tank, sprinkling filter and secondary sedimentation	.....	Trib. to Millstone River
Princeton ..... (Northwest Plant)	Municipality	Princeton	Sedimentation and sand filtration	.....	Trib. to Millstone River
Red Bank	Municipality	Red Bank	Sedimentation and hypochlorite disinfection	.....	North Branch of Navesink River
Ridgefield	Municipality	Ridgefield	Imhoff tank	.....	.....
Ridgefield Park .. (East Side Plant)	Municipality	Ridgefield Park	Imhoff tank	.....	Overpeck Creek
Ridgefield Park .. (West Side Plant)	Municipality	Ridgefield Park	Imhoff tank	.....	.....
River Edge	Municipality	River Edge	Imhoff tank	.....	Hackensack River
Riverside	Municipality	Riverside	Sedimentation	.....	Delaware River

New Jersey Municipal Sewage Treatment Plants—Continued

Location	Owner	Treating Sewage from	Type of Plant	Gallons Treated per Day	Effluent Discharged into
Roebling	John A. Roebling's Sons Co.	Roebling	Imhoff tank, sprinkling filters and secondary sedimentation	.....	Delaware River
Rumson	Rumson Development Co.	Rumson	Sedimentation and hypochlorite disinfection	.....	Shrewsbury River
Sea Girt	Municipality	Sea Girt	Sedimentation	122,000	Atlantic Ocean
Sea Isle City	Municipality	Sea Isle City	Sedimentation and liquid chlorine disinfection	300,000 (max.)	Ludlam's Thorofare
Seaside Park	Municipality	Seaside Park	Sedimentation and liquid chlorine disinfection	350,000 (max.)	Barnegat Bay
Secaucus	Municipality	Secaucus	Sedimentation	.....	Hackensack River
South Bound Brook	Municipality	S. Bound Brook	Sedimentation	.....	Raritan River
South River.....	Municipality	South River	Sedimentation	.....	South River trib. to Raritan River
Spring Lake..... (3 plants)	Municipality	Spring Lake	Sedimentation	520,000 (max.)	Atlantic Ocean
Stone Harbor.....	Municipality	Stone Harbor	Sedimentation and hypochlorite disinfection	.....	Great Channel
Teaneck Twp..... (3 plants)	Municipality	Teaneck Twp.	Imhoff tanks	.....	Hackensack River
Toms River.....	Municipality	Toms River	Imhoff tanks and liquid chlorine disinfection	.....	Toms River
Trenton	Municipality	Trenton	Imhoff tanks	17,000,000	Delaware River
Ventnor	Municipality	Ventnor	Sedimentation and liquid chlorine disinfection	.....	Beach Thorofare
Verona	Municipality	Verona	Sedimentation, contact beds and intermittent sand filtration	.....	Peckman's Brook
Vineland	Municipality	Vineland	Sand filtration and hypochlorite of lime disinfection	.....	Trib. to Maurice River
Washington	Municipality	Washington	Imhoff tank, plain sedimentation, contact beds and intermittent sand filtration	.....	Shabbacong Creek
Wenonah ..... (2 plants)	Municipality	Wenonah	Sedimentation and intermittent sand filtration	.....	Mantua Creek
Westville	Municipality	Westville	Sedimentation and separate sludge digestion	.....	Delaware River
West Wildwood....	Municipality	West Wildwood	Sedimentation and liquid chlorine disinfection	.....	.....
*Westwood	Municipality	Westwood	Sedimentation and intermittent sand filtration	.....	Hackensack River
Wildwood	Municipality	Wildwood	Mechanical screening and liquid chlorine disinfection	.....	Post Creek trib. to Grassy Sound
Wildwood Crest...	Municipality	Wildwood Crest	Mechanical screening and liquid chlorine disinfection	8,000	Sunset Lake
Woodbridge Twp...	Municipality	Avonel Section of Woodbridge Twp.	Sedimentation	.....	Woodbridge Creek
Woodbridge Twp...	Municipality	Edgars Section of Woodbridge Twp.	Sedimentation	.....	Woodbridge Creek
Woodbridge Twp...	Municipality	Fords Section of Woodbridge Twp.	Imhoff tank	.....	Woodbridge Creek
Woodbridge Twp... (2 plants)	Municipality	Port Reading section of Woodbridge Twp.	Sedimentation	.....	Woodbridge Creek
Woodbridge Twp..	Municipality	Ridgedale section of Woodbridge Twp.	Sedimentation	.....	Woodbridge Twp.
Woodbridge Twp..	Municipality	Sewaren section of Woodbridge Twp.	Sedimentation	.....	Woodbridge Twp.
Woodbridge Twp..	Municipality	Woodbridge Ave. section of Woodbridge Twp.	Sedimentation	.....	Woodbridge Twp.
Woodbridge Twp..	Municipality	Hopelawn section of Woodbridge Twp.	Sedimentation	.....	Woodbridge Creek
Woodbury ..... (2 plants)	Municipality	Woodbury	Imhoff tanks	.....	Woodbury Creek
Woodbury Hts.....	Municipality	Woodbury Hts.	Imhoff tanks and sprinkling filters	.....	Woodbury Creek
Woodlynne	Municipality	Woodlynne	Imhoff tank	.....	N. Branch Newton Creek
Woodridge	Municipality	Woodridge	Grit and screen chambers, settling tanks, sprinkling filters and secondary settling tanks	.....	Berry's Creek, a trib. of Hackensack River
Woodstown	Municipality	Woodstown	Sedimentation and intermittent sand filtration	.....	Salem Creek
Wrightstown	Municipality	Wrightstown	Sedimentation and sand filtration	.....	Crosswicks Creek

Sewage Treatment in Utah

Information Furnished by State Board of Health

Town	Population	Per cent of Pop. Sewered	Treatment
Cedar City	2,462	Bus. Sect.	Septic tank and dilution in small stream
Helper	1,606	20%	Septic tank and dilution in Price river
Hiawatha	1,408	46%	Septic tank and dilution in small stream
Midvale	2,209	30%	Septic tank and dilution
Milford	1,308	20%	Septic tank and dilution in small stream
Murray	4,584	50%	Septic tank and dilution in Cottonwood creek
Richfield	3,262	10%	Septic tank
Standardville	545	75%	Septic tank & contact bed (latter useless)
Storrs	656	75%	Septic tank and dilution in creek
Soldier Summit	1,500	80%	Septic tank

Municipal Sewage Treatment Plants in Pennsylvania

Municipality	Method of Treatment
Troy	Imhoff tank, sludge bed and chlorinated lime.
State College	Imhoff tank, trickling filter, resettling basin, sludge bed, chlorinated lime and chlorine gas
Barrett	Septic tank, sand filter, trickling filter, resettling basin, sludge bed, chlorinated lime
Conyngham	Septic tank, chlorinated lime
E. Stroudsburg	Screens, septic tank, contact bed and sludge bed.
Hanover	Screen, Imhoff tank, sludge bed, chlorine gas
Montrose	Screen, Imhoff tank, resettling basin, sludge bed, chlorinated lime, chlorine gas.
Montrose	Septic tank, chlorinated lime
Beaver Falls	Screen, Imhoff tank, sludge bed, chlorine gas
Greenville	Screen, Imhoff tank, resettling tank, sludge bed, chlorine gas
Grove City	Screen, sedimentating tanks, sludge bed
Mars	Septic tank, sludge bed, chlorinated lime
Mercer	Screen, septic tank, sludge bed
New Wilmington	Screen, septic tank, sand filter, sludge bed
North East	Screen, Imhoff tank, trickling filter, resettling basin, sludge bed
Pleasantville	Imhoff tank, trickling filter, resettling basin, sludge bed
Slippery Rock	Screen, Imhoff tank, trickling filter, sludge bed
Brentwood	Septic tank, sludge bed
Derry	Septic tank, contact bed, sludge bed
Dormont	Septic tank
Dormont	Septic tank, contact bed.
Indiana	Screen, septic tank, trickling filter, resettling basin, sludge bed
Mt. Lebanon	Septic tanks (2 plants)
Oakdale	Screen, septic tank, sludge bed
Washington	Screen, septic tank, trickling filter, resettling basin, sludge bed
Bristol	Screen, Imhoff tank, sludge bed
Downingtown	Screen, Imhoff tank, trickling filter, resettling basin, sludge bed, chlorine gas
Doylestown	Screen, septic tank, trickling filter, resettling basin, sludge bed
Media	Screen, settling tanks and separate sludge digestion tanks, trickling filter, resettling basin, sludge bed
North Wales	Screen, Imhoff tank, trickling filter, resettling basin, sludge bed
Parkesburg	Screen, Imhoff tank, resettling basin, sludge bed, chlorinated lime
Sellersville	Screen, septic tank, trickling filter, resettling basin, sludge bed, chlorine gas
Philadelphia	Screen, Imhoff tank, trickling filter, sludge bed, chlorine gas
Philadelphia	Screen, Imhoff tank, trickling filter, resettling basin, sludge bed, chlorinated lime
Philadelphia	Screen, grit chamber, Imhoff tank, sludge bed
So. Coatesville	Screen, Imhoff tank, trickling filter, resettling basin, sludge bed (2 similar plants)
Wayne	Screen, septic tank, sand filter, trickling filter, resettling basin, sludge bed, chlorinated lime
West Chester	Septic tank, trickling filter, resettling basin, sludge bed, chlorine gas (2 similar plants)
Altoona	Imhoff tank
Altoona	Screen, irrigation field
Carlisle	Septic tank, contact bed, sludge bed
Chambersburg	Screen, Imhoff tank, trickling filter, resettling basin, sludge bed
Ebensburg	Screen, Imhoff tank, trickling filter, resettling basin, sludge bed
Granville	Septic tank
Gettysburg	Screen, Imhoff tank, sludge bed, chlorinated lime
Green	Septic tank, irrigation field, chlorinated lime.
Hanover	Septic tank, contact bed, sludge bed, chlorinated lime
Loretta	Imhoff tank, contact bed, sludge bed, chlorinated lime
Washington	Septic tank, sub-surface irrigation
York	Screen, Imhoff tank, sludge bed, chlorine gas
Lebanon	Screen, Imhoff tank, trickling filter, resettling basin, sludge bed, chlorine gas
Elizabethtown	Screen, Imhoff tank, trickling filter, resettling basin, sludge bed, chlorine gas
Bethlehem	Screen
Reading	Screen, septic tank, trickling filter, resettling basin, sludge bed, chlorinated lime
Nazareth	Septic tank, chlorinated lime
Allentown	Screen, electrolytic tank, resettling basin, sludge bed
Middle Cove	Screen, septic tank, sand filter

California Sewage Treatment Plants

In sending us information concerning the sewage treatment plants in the State of California, C. G. Gillespie, Director of the Bureau of Sanitary Engineering, furnished a general report on the satisfactoriness of the operation of the plants, classifying them as good, fair or poor. Conditions considered most important were the seriousness of odor nuisances from the plant itself or from the disposal, and the pollution of water, garden truck, etc., as a possible menace to health.

Of the 152 plants, only 18 were classed as good, while 52 were considered to give poor results. The remaining 81, or a little over 50%, were classed as fair. Grouping the results according to the type of plant used for tank or other primary treatment, we find that those employing Imhoff tanks were considered good in five cases, fair in 24 and poor in 19. Where septic tanks were used, 7 plants were considered good, 50 fair and 27 poor. Six activated sludge plants gave good results and two, fair results. Three plants using screens gave fair results and six, poor results.

The secondary treatment, of course, plays a considerable part in determining the condition of the plant, and the above comparison between Imhoff and septic tanks may not be a fair one. Where Imhoff tanks were used alone, two were good, 8 fair and 6 poor; Imhoff and sprinkling filters, 7 fair and 2 poor; Imhoff and sub-irrigation, one plant, fair; Imhoff and contact beds, one fair and one poor; Imhoff and farm treatment, 2 good, 6 fair and 7 poor; Imhoff, sprinkling filter and chlorine, one good; Imhoff and chlorination, one fair and two poor.

Septic tanks alone gave good results in 5 cases, fair in 36 and poor in 15; septic and sprinkling filters, fair in 2 cases; septic and farm treatment, good in one case, fair in 11 and poor in 11; septic and contact beds, one poor; septic, contact beds and farming, one fair; septic and chlorine, one good.

Of the 152 plants reported, 5.3% employed activated sludge, 5.9% screens, 30.9% Imhoff tanks and 55.3% septic tanks, while 2.6% employed other devices. Nine plants chlorinated the effluent from tanks or other treatment.

Sewage Treatment Plants in California

Information Furnished by State Board of Health

City	Population Est. 1922	Treatment	Disposal
Alhambra	9,910	Activated sludge	Sand & Rio Hondo river
Anaheim	5,526	Fine screens	Ocean
Atascadero	2,000	Imhoff tank	Sub-irrigation, overflow into Salinas river
Auburn	2,289	Imhoff tank	Auburn ravine
Avalon	586	Septic tank	Ocean
Bakersfield	18,638	Septic tank	Sewer farm
Beverly Hills	700	Sept. tank-trickling filter	Dry wash
Biggs	740	Imh. tank-sprink. filter	Fleming ditch
Bishop	1,330	Septic tank	Creek, thence to Owens riv.
Boulder Creek	550	Septic tank	San Lorenzo river
Brookdale	25	Septic tank	San Lorenzo river
Calexico	7,313	Septic tank	New river
Calipatria	850	Septic tank	Alamo river
Calistoga	868	Sept. tank (separate sludge)	Napa river
Ceres	650	Imhoff tank	Filter beds
Chico	10,453	Imhoff tank	Sewer farm
Chino	2,264	Septic tank	Sewer farm
Clovis	1,200	Imhoff tank	Sewer farm
Clyde	75	Septic tank	Sloughs
Coalinga	3,000	Septic tank	Dry cr. to waste country
Colfax	600	Septic tank	Creek, to Bear river
Colusa	1,900	Imhoff tank-contact beds	Ponds
Compton	1,588	Septic tank	Compton creek
Concord	952	Imhoff tank	Sewer farm
Corcoran	1,125	Septic tank	Sewer farm
Corona	4,245	Imh. tank sprink. filter	Sewer farm
Davis	1,000	Imhoff tank	Putah creek
Delano	830	Imh. tank sprink. filter	Sewer farm
Dinuba	3,886	Septic tank contact beds	Alta drainage ditch
Dixon	950	Septic tank	Sewer farm
East San Diego	4,200	Imhoff tank	San Diego river
El Centro	6,234	Septic tank	Alamo river
El Monte	1,310	Septic tank	Rio Hondo
Elsinore	661	Septic tank	Sewer farm
Etna Mills	450	Imhoff tank	Mill creek, Salmon river
Exeter	1,900	Imhoff tank	Sewer farm
Firebaugh	500	Septic tank	Drain ditch, irrigat'n canal
Folsom	1,300	Imhoff tank	American river filtered through boulders
Fortuna	1,000	Septic tank	Sand bar, Eel riv. nr. mouth
Fowler	1,688	Imhoff tank	Sewer farm
Fresno	49,124	Septic tank	Sewer farm
Fullerton	4,953	Fine screens	Ocean
Gilroy	2,886	Septic tank	Drain canal to Pajaro riv.
Glendale	15,694	Fine screens	Ocean
Gridley	1,764	Septic tank	Drain ditch
Gustine	730	Septic tank	Ponds, to San Joaquin river
Hammonton	500	Imhoff tank	Ponds
Hanford	5,998	Septic tank	Sewer farm
Healdsburg	2,492	Septic tank	Dry creek
Hemet	1,576	Septic tank	Sewer farm
Hermosa Beach	2,655	Septic tank	Sewer farm
Hobart Mills	200	Imhoff tank	Creek, & to Truckee river
Hollister	2,875	Septic tank	Sewer farm
Holtville	1,479	Septic tank	Sewer farm
Huntington Beach	1,860	Imhoff tank	Ocean
Imperial	1,914	Septic tank	Alamo river
King City	1,055	Imh. tank sprink. filter	Salinas river
Kingsburg	1,452	Septic tank	Kings river
Lakeport	1,054	Septic tank	Clear lake
Lemoore	1,425	Septic tank	Sewer farm
Lincoln	1,325	Sprinkling filter	Auburn rav, Sacramento riv
Lindsay	2,728	Activated sludge	Sewer farm
Livermore	1,920	Imhoff tank	Sewer farm
Lodi	5,080		Woodbridge canal
Lompoc	1,954		Santa Ynez river
Stockton	43,704	Imh., screens, chlorination	San Joaquin river
Susanville	964	Septic tank	Drainage way, to Susan riv.
Taft	3,350	Imhoff tank	Natural drain & to waste country
Tracy	2,460	Imh. tank sprink. filter	Barge canal
Truckee San. Dist.	....	Septic tank	Truckee river
Tulare	3,694	Septic tank	Sewer farm
Turlock	3,758	Activated sludge	Chatam drain & to San Joaquin river
Ukiah	2,337	Imhoff tank	Sewer farm & Russian riv.
Vacaville	1,254	Septic tank	Sewer farm, drain to creek
Venice	11,837	Fine screens, chlorine	Ocean
Vernon	1,051	Fine screens	Ocean
Visalia	5,993	Imhoff tank	Sewer farm
Walnut Creek	538	Imhoff tank, contact beds	San Ramon creek
Walnut Grove	350	Septic tank	Mokelumne slough
Weaverville San. D.	....	Septic tank	Cesspools, Weaver creek to Trinity river
Weed	900	Ponds & sawdust filters	Boles creek to Shasta river
Whittier	8,685	Imhoff tank	Sewer farm, drain San Gabriel river
Willits	1,530	Septic tank	Creek
Willows	2,500	Septic tank	Sewer farm
Winters	903	Imhoff tank	Putah creek, gravel beds in summer
Yosemite	....	Imhoff tank, sand filters, chlorination	Merced river
Yreka	1,305	Septic tank	Creek, to Klamath river

Sewage Treatment Plants in Texas

M—Municipal. P—Private. Co.—County. St.—State.

At least ten more plants were contemplated (December, 1924) in the near future

Town	Ownership	Type of Plant	Effluent Discharged Into
Abilene	M	Septic tanks and irrigation—2	Creek and river
Alto	M	Disposal plant and chlorine	Creek and river
Alvin	P	Septic tank	Bayou and "Tidal Wave"
Amarillo	M	Imhoff tank and irrigation	City farm
Anson	Co.	Imhoff tank and irrigation	Creek and river
Arlington	M	Imhoff tank and filter	Creek and river
Athens	P	Imhoff tank and filter	.....
Atlanta	M	Settling tank	Bayou and river
Austin	P	Imhoff tank and chlorination	River
Ballinger	P	Septic tank and sub-irrigation	River
Bartlett	Co.	Septic tank and contact beds	Creek and river
Bastrop	P	Septic tank	River
Bay City	M	Septic tank and contact beds	Creek and river
Beeville	M	Septic tnak	River
Belton	M	Imhoff tank and splash filter	Draw and river
Big Spring	M	Settling tank and chlorine	Creek and tide water
Bishop	P	Settling tank and contact bed	Creek and river
Bonham	P	Septic tank	Sub-irrigation
Bowie	M	Septic tank and irrigation	Creek, fork and river
Breckenridge	M	Imhoff tank, filters and chlorine	Creek and river
Brenham	M	Septic tanks (2)	River
Brownsville	M	Dorr clarifier, separate sludge digestion and chlorine	Bayou and river
Brownwood	M	Septic and Imhoff tanks and irrigation	River
Bryan	M	Imhoff tank and sprinkling filter	River
Burkburnett	P	Disposal plant	Creek and river
Calvert	M	Imhoff tank, filter and chlorine	River
Canadian	M	Imhoff tank	Fork and river
Canyon	M	Septic tank	River
Carthage	M	Imhoff tank and chlorine	River
Center	M	Imhoff tank and chlorine	.....
Childress	M	Imhoff tank and sprinkling filter	River
Chillicothe	M	Imhoff tank, sprinkling filter and hypochlorite	River
Celina	M	Imhoff tank, contact bed and chlorine	River
Cisco	M	Septic tank and activation	Fork and river
Clarendon	M	Imhoff tank and filter	

Long Beach	63,149	Screens	Ocean
Los Angeles	628,167	Fine screens	Ocean
Los Banos	1,382	Septic tank	Mud sl. to San Joaquin riv.
Los Gatos	2,330	Imhoff tank	Los Gatos creek
Madera	3,552	Imh. tank sprink. filter	Sewer farm
Manteca	1,300	Doten septic tank	Sewer farm
Martinez	4,206	Imhoff tank	Carquinez straits
McCloud	400	Septic tank	Creek, thence to McCloud river
Merced Falls	50	Septic tank chlorine	Merced river
Modesto	10,281	Septic tank	Sewer farm & Tuolumne R.
Monrovia	5,860	Septic tank	San Gabriel wash
Morgan Hill	650	Imh. tank sprink. filter	Creek, to Pajaro river
Mountain View	2,032	Septic tank	Sloughs, San Francisco bay
Mt. View Sanitary District	....	Septic tank	Slough
Newcastle	750	Imhoff tank	Secret ravine, Antelope crk.
Newman	1,321	Septic tank	Sloughs, to San Joaquin riv.
Newport Beach	982	Imhoff tank	Ocean
Oceanside	1,257	Septic tank	Ocean
Ojai (not built)	500	Imh. tank sprink filters, sand filters	Ventura river
Orange	5,276	Screens	Ocean
Orland	1,730	Septic tank	Sewer farm
Oroville	3,340	Septic tank	Feather river
Oxnard	4,787	Septic tank	Ocean
Pasadena	48,366	Activated sludge	Sand & Rio Hondo river
Paso Robles	1,993	Imhoff tank	Salinas river
Patterson	700	Imhoff tank	Sewer farm
Pismo (not built)	150	Septic tank	Ocean
Pittsburg	5,183	Septic tank	San Joaquin river
Pleasanton	1,306	Septic tank	Sewer farm & to Niles crk.
Pomona	14,163	Septic tank	Creek to Santa Ana river
Porterville	4,377	Septic tank	Sewer farm
Reedley	2,480	Imhoff tank, sprink. filter & chlorination	Kings river
Represa (State Prison)	....	Act. sludge & chlorination	American river
Rio Vista	1,148	Septic tank	Sacramento river
Riverbank	800	Septic tank	Stanislaus river
Roseville	4,750	Septic tank	Antelope creek to Sacramento river
Ross	760	Imhoff tank, chlorination	San Francisco bay
Salinas	4,422	Septic tank	Sewer farm, Salinas river
San Anselmo	2,663	Imhoff tank, chlorination	Sloughs, San Francisco bay
San Bernardino	19,909	Septic tank	Sewer farm, Warm creek
San Bruno	1,575	Septic tank	Sloughs, San Francisco bay
San Diego, Ocean Park Dist.	....	Imhoff tank	Ocean
Sanger	2,600	Septic tank	Sewer farm, China slough
San Juan Bautista	537	Imh. tank sprink. filter	Drain to Pajaro river
San Luis Obispo	6,040	Septic tank	San Luis creek
San Marino	600	Activated sludge	(With Pasadena)
Santa Ana	16,895	Screens	Ocean
Santa Barbara	20,997	Fine screens	Ocean
Santa Clara	5,128	Septic tank	Guadalupe creek
Santa Cruz	10,917	Septic tank	San Lorenzo river, Bay
Santa Maria	4,280	Imhoff tank	Sewer farm
Santa Monica	16,732	Electrolitic plant, chlorine	Ocean
Santa Paula	4,317	Imhoff tank	Sewer farm
Santa Rosa	8,946	Septic tank	Santa Rosa creek
Saratoga	600	Septic tank	Cesspools, creek
Sawtelle, Old Soldiers' Home	....	Septic tank, contact beds	Sewer farm
Scotia	900	Septic tank	Eel river
Seal Beach	669	Imhoff tank	Ocean
Sebastopol	1,545	Septic tank	Laguna Santa Rosa
Selma	3,438	Imhoff tank	Sewer farm
Shasta Springs	40	Septic tank	Cesspools, to Sacramento riv
Sisson (Mt. Shasta)	654	Septic tank	Creek
Sonoma	801	Septic tank	Sewer farm & creek
Sonoma State Home	....	Imh. tank sprink. filter	Sonoma creek
Sonora	1,684	Two septic tanks	Woods creek to Tuolumne R.
So. Pasadena	8,248	Activated sludge	(With Pasadena)
St. Helena	1,349	Septic tank	Napa river

Clarksville	M	Imhoff tank and filter	River
Cleburne	M	Imhoff tank, sprinkling filter and secondary settling tank	Creek and river
Clifton	M	Disposal plant	Creek and river
Coleman	P	Septic and activated sludge tanks	Creek and river
Colorado	M	Disposal plant	River
Comanche	M	Imhoff tank, sprinkling filters and chlorine	Creek and river
Commerce	M	Septic tank and sub-irrigation	River
Corpus Christi	M	Septic tanks and contact beds	Tide water
Corsicana	M	Imhoff tanks, sprinkling filters, secondary settling and chlorine	Creeks and river
College Station	St.	Imhoff tank and sprinkling filter; Septic tank	River
Crockett	M	Imhoff tank and sprinkling filters	Creek and river
Cuero	M	Imhoff tank	Creek and river
Dalhart	M	Imhoff tank and sprinkling filter	Canyon and river
Dallas	M	Imhoff tank	River
Decatur	M	Septic tanks	Fork and river
De Leon	M	Imhoff tank, sprinkling filter and chlorine	Creek and river
Del Rio	M	Imhoff tank and sprinkling filter	River
Denton	M	Imhoff tank and sprinkling filter	Creeks and river
Desdemona	P	Septic tank and contact beds	River
Dublin	M	Septic tank and contact beds	Creek and river
Eagle Lake	M	Septic tank and sub-irrigation	River
Eagle Pass	M	Septic tank	River
Eastland	M	Imhoff tank and sprinkling filter; Septic tank and contact bed	.....
Electra	M	Imhoff tank and sprinkling filters	Creek and river
Elgin	M	Septic tanks, contact beds and hypochlorite	.....
El Paso	M	Settling tank and chlorine	River
Ennis	M	Imhoff tank and Dunbar beds	Creek and river
Falfunias	P	Imhoff tank, filter and sub-irrigation	Drainage ditch and creek
Farmersville	M	Imhoff tank and chlorine, 2 plants	Rivers
Ferris	M	Disposal plant	Creek and river
Floydada		Imhoff tanks and contact beds	.....
Forney	M	Imhoff tank, filter and hypochlorite	River
Fort Worth	M	Imhoff tank, sprinkling filter, secondary settling and chlorine	.....
Frost	M	Sprinkling filters	Creek and river
Gainesville	M	Activated sludge	.....
Garland	M	Imhoff tank and chlorine	Creek and river
Gatesville	M	Settling tank, contact beds and chlorine	River
Georgetown	P	Septic tank and sub-irrigation	River
George West	P	Disposal plant	River
Gilmer	M	Septic tank (improvements ordered)	Creek
Goliad	M	Imhoff tank, contact beds and chlorine	River
Gonzales	M	Imhoff tank and contact beds	River
Gorman	M	Disposal plant and chlorine	River
Graham	M	Activated sludge and sand filters	Creek and river
Grand Saline	M	Imhoff tank and sprinkling filters	River
Granger	M	Settling tank and contact beds	Creek and river
Gregory	P	Septic tank	Tide water
Greenville	M	Imhoff tank and contact beds	River
Groesbeck	M	Septic tank and chlorine	Creek and river
Gulf	P	Septic tanks	Tide water and bay
Hamilton	M	Septic tank and contact beds	Creek and river
Hamlin	M	Imhoff tank	Creek and river
Harlingen	M	Imhoff tank and hypochlorite	Arroya

Harrisburg	M	Imhoff tank and sprinkling filters	Tide water	Park Place	M	Imhoff tanks	Bayou and tide water
Haskell	M	Septic tank	Fork and river	Pecos	M	Septic tank	River
Hearne	M	Imhoff and septic tanks	Creek and river	Pampa	M	Imhoff tank and sprinkling filters	Canyon
Henderson	P	Lagooning	River	Pittsburgh	M	Imhoff tank, sprinkling filters, secondary settling and hypochlorite	Creek and lake
Henrietta	M	Disposal plant and chlorine	Rivers	Plainview	M	Imhoff tank and sprinkling filters	Creek and river
Hereford	M	Disposal plant and sub-irrigation	Canyon and river	Plano	M	Imhoff tank and chlorine	River
Hico	P	Disposal plant	River	Post City	P	Disposal plant	River
Hillsboro		Imhoff tank and sprinkling filters	Creek and river	Ranger	P	Imhoff tank, filters and chlorine	River
Honey Grove	M	Septic tank, Dunbar bed and hypochlorite	Creek and river	Rising Star	M	Disposal plant	River
Houston	M	Activated sludge	Bayou	Robstown	M	Imhoff tank and chlorine	Creek and tide water
Hubbard City	M	Septic tank	Creek and river	Rockdale	M	Septic tank	River
Huntsville	M, St	Imhoff tank, sprinkling filters and chlorine	Creek and river	Royse City	P	Septic tanks and hypochlorite	
Iowa Park	M	Imhoff tank and chlorine	Rivers	Rusk	M	Septic tank	River
Itasca	M	Imhoff tank	Creek and river	San Angelo	P	Activated sludge	River
Italy	M	Settling tanks and contact beds, (2 plants)	Creek and river	San Antonio	M	Lagooning	Lake
Jacksonville	M	Imhoff tank and sprinkling filters	Creek	San Benito	M	Septic tank, contact beds and hypochlorite	Tide water
Jefferson	P	Imhoff tank, contact beds and hypochlorite	Lake and river	Sanger	M	Imhoff tank and chlorine	
Kaufman	M	Imhoff tank and contact beds	Creek and river	San Marcos	P	Activated sludge and hypochlorite	River
Kenedy	M	Septic tank	River	San Saba	Co.	Disposal plant	River
Kerens	P	Imhoff tank	Creek and river	Santa Anna	M	Septic tank and contact beds	Creek and river
Kerrville	M	Imhoff tank, chlorine and irrigation	River	Seguin	M	Imhoff tank and sprinkling filters	River
Kingsville	M	Imhoff tank and sub-irrigation	Creek and tide water	Seymour	M	Imhoff tank and sprinkling filters	Creek and river
Ladonia	M	Imhoff tank, filter and chlorine	River	Sherman	M	Activated sludge	Creek and river
La Grange	M	Imhoff tank, sprinkling filters and hypochlorite	River	Shiner	M	Septic tank, contact beds and hypochlorite	Creek and river
Lancaster	M	Imhoff tanks, Dunbar beds and hypochlorite	Creek and river	Sinton	M	Septic tank and hypochlorite	
Laredo	M	Imhoff tank and chlorine	River	Slaton	M	Imhoff tank	River
Lamesa	M	Imhoff tank, filter and chlorine	Draw and river	Sinco	P	Septic tank and sand filters	River
Leonard	M	Imhoff tank and chlorine	River	Smithville	P	Septic tank and contact beds	River
Llano	M & Co.	Imhoff tank and contact beds	Rivers	Snyder	M	Imhoff tank and splash filters	Creek
Lockhart	M	Imhoff tank and sprinkling filters	Creek and river	Spur	P	Septic tank	Creek and river
Lubbock	M	Imhoff tank, sprinkling filters and chlorine	Canyon and river	Stamford	M	Imhoff tank, sprinkling filters and chlorine	Creek
Lufkin	M	Septic tank and contact beds (2 plants)	River	Stephenville	M	Septic tank and Dunbar beds	River
Magnolia Park		Imhoff tank and sprinkling filters	Tide water	Sulphur Springs	M	Septic tank	Creeks
Marlin	M	Imhoff tank and sprinkling filters	River	Sweetwater	P	Imhoff tank and sprinkling filters	Creek and river
Marshall	M	Settling tank and contact beds	Creek and river	Taft	P	Septic tank	Tide water
Mart	P	Septic tanks	River	Taylor	P	Settling tank and cinder bed	Creek and river
Matagorda	P	Settling tanks	Tide water	Teague	P	Imhoff tank and sub-irrigation	Creek
McAllen	M	Septic tanks and broad irrigation	Arroya and rivers	Temple	M	Septic tank and gravel contact beds	River
McKinney	P	Imhoff tank and sprinkling filter	Creek	Terrill	P	Septic tank	Creek and river
Memphis	M	Septic tank and sprinkling filters	Creek and river	Texarkana	M	Imhoff tank and sprinkling filters	River
Mercedes	M	Imhoff tank and sprinkling filters	Arroya and rivers	Tulia	M	Imhoff tank and sprinkling filters	Canyon
Mexia	M	Imhoff tank and chlorine	Creek and river	Tyler	P	Imhoff tank and Dunbar filters	Fork and river
Mineola	M	Settling tank, contact beds and hypochlorite	River	Uvalde	M	Septic tank and sub-irrigation	Rivers
Mineral Wells	M	Imhoff tank and sprinkling filters	River	Van Alstyne	M	Imhoff tank, sprinkling filters and chlorine	River
Mission	M	Septic tank	Rivers	Venus	M	Imhoff tank and contact beds	River
Mt Pleasant	M	Septic tank	Creek	Vernon	M	Natural sand bed	River
Nacogdoches	M	Imhoff tank and filters	Bayou and river	Victoria	M	Imhoff tank and sprinkling filter	River
Navasota	M	Imhoff tank, sprinkling filters and hypochlorite	Rivers	Waxahachie	M	Imhoff tank, sprinkling filters and hypochlorite	Creek and river
Nocona	M	Imhoff tank and hypochlorite	River	Weatherford	M	Septic tank and filters	River
Olney	M	Disposal plant and chlorine	Creek and river	West	M	Septic tank and contact beds	River
Palacios	P	Disposal plant	Tide water	Whitewright	M	Imhoff tank, contact beds and chlorine	Creek and river
Palestine	P	Lagooning	Creek and river	Wills Point	M	Imhoff tank, contact beds and hypochlorite	River
Paris	M	Activated sludge and chlorine (2 plants)	River	Winnsboro	M	Septic tank and contact beds	Creek
				Winters	M	Imhoff tank and chlorine (filters ordered)	Creeks and river
				Wortham	P	Imhoff tank; septic tank and sub-irrigation	Creeks and river
				Wylie	M	Disposal plant	River
				Yoakum	M	Septic tank	Creek and river

Sewage Treatment Plants in Iowa

CITY	KIND OF PLANT
Ackley	Septic tank and sand filters
Afton	Septic tank and sand filters
Albia	Imhoff tank and sand filters
Alden	Septic tank
Alta	Septic tank and sand filters
Alton	Septic tank and sand filters
Ames	Imhoff tank and trickling filters
Ankeny	Imhoff tank and sand filters
Anthon	Septic tank and sand filters
Arlington	Imhoff tank and trickling filters
Arnold's Park	.....
Arthur	.....
Ashton	.....
Audubon	Septic tank and sand filters
Aurelia	Septic tank and sand llters
Bancroft	Imhoff tank and sand filters
Baxter	Septic tank and trickling filters
Bedford	Imhoff tank and sand filters
Belmond	Septic tank
Bloomfield	Septic tank
Bode	Septic tank and sand filters
Boyden	Imhoff tank and sand filters
Brighton	Imhoff tank and sand filters
Brooklyn	Imhoff tank and sand filters
Burt	Septic tank and sand filters
Calmar	Imhoff tank and trickling filters
Carroll	Sand filters
Centerville	Imhoff tank and sand filters
Chariton	Imhoff tank and sand filters
Charter Oak	Septic tank and sand filters
Churdan	Septic tank and sand filters
Clarion	Imhoff tank and sand filters
Clear Lake	Septic tank and sand filters
Conrad	Septic tank and sand filters
Coon Rapids	Septic tank and sand filters
Corwith	Imhoff tank and sand filters
Corydon	Two septic tanks
Creston	Imhoff tank and sand filters
Dayton	Imhoff tank and trickling filters
Decorah	Septic tank and sand filters
Denver	Septic tank and sand filters
De Witt	Septic tank and sand filters
Dexter	Septic tank and sand filters
Doon	Imhoff tank and sand filters
Dows	Septic tank and sand filters
Durant	Septic and sedimentation tanks and trickling filters
Dysart	Septic tank and sand filters
Early	Septic tank and sand filters
Elma	Septic tank and sand filters
Emmetsburg	.....
Fairfield	Imhoff tank and sand filters
Farley	Septic tank and sand filters
Fayette	Septic tank and sand filters
Fonda	Imhoff tank and sand filters
Fredricksburg	Imhoff tank and sand filters
Garner	Septic tank and sand filters
Garwin	Septic tank and sand filters
George	Septic tank and sand filters
Gilmore City	Septic tank and trickling filters
Grand Mound	Septic tank and sand filters
Granville	Imhoff tank and sand filters
Greene	Septic tank
Grinnell	Imhoff tank and sand filters
Grundy Center	Imhoff tank
Guthrie Center	Septic tank and sand filters
Hampton	Imhoff tank and trickling filters
Harris	Imhoff tank and sand filters
Hartley	Imhoff tank and sand filters
Hawkeye	Septic tank and sand filters
Holstein	Sand filters
Hospers	Septic tank and sand filters
Hudson	Septic tank and sand filters
Hull	Septic tank and sand filters
Indianola	Septic tank and sand filters
Inwood	Imhoff tank and trickling filters
Jefferson	Septic tank and contact filters
Jewell	Septic tank and sand filters
Kanawha	Imhoff tank and sand filters
Kenwood Park	Septic tank and sand filters
Keota	Septic tank and sand filters
Kingsley	Septic tank and sand filters
Klemme	Imhoff tank and trickling filters
Knoxville	Imhoff tank and sand filters
Lake City	Imhoff tank and trickling filters
Lake Mills	Septic tank and sand filters
Lake View	Septic tank and sand filters
Lamoni	Imhoff tank and contact filters
La Porte City	Septic tank and sand filters
Laurens	Septic tank and sand filters
Lenox	Imhoff tank and sand filters
Leon	Imhoff tank and sand filters
Lisbon	Septic tank and sand filters
Little Rock	Imhoff tank and trickling filters
Livermore	Imhoff tank and trickling filters
Lohrville	Imhoff tank and sand filters
Madrid	Septic tank and trickling filters
Manson	Imhoff tank and sand filters
Mapleton	Septic tank and sand filters
Marcus	Imhoff tank and sand filters
Marion	Septic tank and sand filters
Mason City	Imhoff tank and trickling filters
Mediapolis	Septic tank
Milford	Septic tank and sand filters
Monona	Septic tank and sand filters
Montezuma	Imhoff tank and sand filters
Mount Ayr	Septic tank and contact filters
Mount Pleasant	Septic tank and sand filters
Mount Vernon	Septic tank and sand filters
Moville	Septic tank and sand filters
Nevada	Septic tank and sand filters
Newell	Septic tank and sand filters
New Hampton	Imhoff tank and sand filters
New Sharon	Imhoff tank and sand filters
Newton	Imhoff tank and sand filters
Northwood	Septic tank and sand filters
Oakdale	Septic tank and sand filters
Ocheydan	Imhoff tank and trickling filters
Odebolt	Septic tank and sand filters
Oelwein	Septic tank and sand filters
Ogden	Septic tank and trickling filters
Onawa	Imhoff tank and sand filters
Orange City	Septic tank and sand filters
Osage	Septic tank and sand filters
Osceola	Septic tank and sand filters
Oskaloosa	Imhoff tank and contact filters
Paullina	Septic tank and sand filters
Pierson	Imhoff tank and sand filters
Pleasantville	Imhoff tank and trickling filter
Pocahontas	Imhoff tank and trickling filters
Pomeroy	Septic tank and trickling filter
Postville	Septic tank and sand filters
Preston	Septic tank and sand filters
Primghar	Imhoff tank and sand filters
Reinbeck	.....
Remsen	.....
Riceville	Septic tank and sand filters
Rinard	Septic tank and sand filters
Rock Valley	Septic tank and sand filters
Rockwell City	Septic tank and sand filters
Roland	Septic tank and sand filters
Rolfe	Imhoff tank and sand filters
Ruthven	Septic tank and sand filters
Saint Ansgar	Imhoff tank and trickling filters
Sanborn	Imhoff tank and sand filters
Schaller	Septic tank and sand filters
Seymour	Imhoff tank and sand filters
Sheffield	Septic tank and sand filters
Shelby	Septic tank and sand filters
Sheldon	Septic tank and sand filters
Sibley	Septic tank and sand filters
Sioux Center	Imhoff tank and trickling filter
Sigourney	Two septic tanks and sand filters
Spirit Lake	Imhoff tank and sand filters
Stanhope	Imhoff tank and sand filters
Stanton	Septic tank and sand filters
State Center	Septic tank and sand filters
Storm Lake	Septic tank and sand filters
Story City	Septic tank and sand filters
Stratford	Septic tank and sand filters
Strawberry Point	Septic tank and sand filters
Stuart	Imhoff tank and sand filters
Sumner	Septic tank and trickling filters
Sutherland	Septic tank and sand filters
Swea City	Imhoff tank and trickling filters
Tabor	Septic tank and sand filters
Tipton	Septic tank and sand filters
Toledo	Septic tank and sand filters
Traer	Septic tank and sand filters
Tripoli	Septic tank and sand filters
Union	Septic tank and sand filters
Valley Junction	Septic tank and sand filters
Victor	Septic tank and sand filters
Walcott	Septic tank
Wall Lake	Septic tank and sand filters
Waukon	Septic tank
Wellsburg	Imhoff tank and sand filters
West Branch	Septic tank and sand filters
West Burlington	Imhoff tank and sand filters
West Liberty	Septic tank and sand filters
West Union	Septic tank and sand filters
What Cheer	Imhoff tank and sand filters
Williams	Septic tank and sand filters
Williamsburg	Septic tank and sand filters
Wilton	Septic tank and sand filters
Winfield	Septic tank and sand filters

Georgia Sewage Treatment Plants

City	Population 1920 Census	Method of Treatment
Arlington	1,531	Septic tank
Atco (Am. Tex. Co.)	.....	Imhoff tank
Atlanta	200,616	Imhoff tanks and trickling filters
Blackshear	1,329	Septic tank
Boston	1,640	Septic tank
Cairo	1,908	Imhoff tank
Camilla	2,136	Septic tank
Cochran	2,021	Septic tank
Decatur	6,160	Septic tank (part of sewage)
Douglasville	2,159	Septic tank
East Lake	611	Septic tank
Eastman	2,707	Imhoff tank
East Point	5,241	Septic tank
Fort Valley	3,223	Septic tank
Grantville	1,200	Septic tank and trickling filters

City	Population 1920 Census	Method of Treatment
Hartwell	2,323	Septic tank
Jesup	1,941	Imhoff tank
La Grange	17,038	Imhoff tank and trickling filters
Lawrenceville	2,059	Septic tank
Leesburg	786	Septic tank
Manchester	2,717	Septic tank
Marietta	6,190	Septic tank
Pelham	2,640	Septic tank
Richland	1,529	Septic tank
Royston	1,681	Septic tank
Social Circle	1,781	Septic tank
Sylvester	1,547	Imhoff tank
Tennille	1,768	Septic tank
Thomaston	2,502	Septic tank
Thomson	2,140	Septic tank
Tifton	3,005	Septic tank
Vidalia	2,860	Septic tank

List of Sewage Disposal Plants in North Carolina

Town	Type
Asheboro	Septic tanks (3)
Aulander	Septic tank
Apex	Imhoff & Sand filters (2)
Benson	Imhoff & Sand filters (1)
Burlington	Septic tank & contact bed
Badin	Septic tank & sprinkling filters
Cary	Imhoff tank & sand filters
Chapel Hill	Septic tank and lath filters
Chapel Hill	Imhoff tank and sand filters
Concord	Septic tanks
Charlotte	Sed. tank, Dorr Thickeners and chlorination
Cherryville	Septic tanks
Dunn	Imhoff tank and sand filters
Durham	Imhoff (1) septic tank (1)
East Spencer	Septic tank
Fairmont	Septic tank
Forest City	Septic tanks (2) Imhoff (4)
Freemont	Imhoff tank & sand filters
Gibsonville	Septic tanks
Gastonia	Activated Sludge
High Point	Imhoff tanks
Hickory	Imhoff & sprinkling filters
Kings Mt.	Imhoff tanks (2)
Kernersville	Septic tank and sand filters
Thrift	Septic tank and sand filters
Littleton	Septic tanks (4)
Louisburg	Septic tank & chlorination
Maiden	Septic tanks (3)
Marshville	Septic tanks (4)
Mooresville	Imhoff & sand filters
Mt. Olive	Septic tank & sand filter
Mt. Airy	Septic tank
Roseboro	Septic tank (2)
Rutherfordton	Septic tank (2)
Robersonville	Septic tank (2)
Rocky Mt.	Septic tanks & chlorination
Sanford	Imhoff tank and sand filters
Siler City	Imhoff tank
Southern Pines	Imhoff tank & sand filters
Selma	Digestion tank and chlorination
Star	Septic tanks (3)
Thomasville	Imhoff tank & contact bed
Tarboro	Septic tank & chlorination
Taylorsville	Septic tank
Whiteville	Septic tanks (2)
Winston-Salem	Direct Oxidation
Wendell	Imhoff tank

Sewage Treatment Plants in Connecticut

Information Furnished by the State Department of Health. As of June 30, 1924.

City	Method of Treatment	Condition when inspected, and remarks
Bridgeport	Fine screens, 1-32-inch slots	Good. Screenings used for fertilizer on City Farm. Only 15% of total sewage treated.
Bristol	Sand filtration	In excellent condition. Effluent clear & odorless.
Canaan	Septic tank	Effluent well clarified. Fairly heavy scum. Cleaning of tank recommended.
Danbury	Sand filters and chlorination	Filters for day flow only. Chlorination only for excess night flow. Filters in excellent condition. Sewage flow exceeds plant capacity.
Danielson	Sedimentation in shallow gravel basin	Conditions very objectionably. Plant practically useless. New plans under consideration.
Greenwich (main plant)	Imhoff tanks and chlorination	Chlorination not operating. Additional sludge disposal area required.
Greenwich (East Port Chester plant)	Septic tanks and chlorination	Chlorination not operating. Additional sludge disposal area required.
Lakeville	Imhoff tank and sand filtration	
Litchfield	Sand filtration	
Manchester	Septic tank	Slight odor. Appearance of effluent indicated need of cleaning.
Meriden	Sand filtration	
Middletown (2)	Imhoff tanks	Main plant, poor condition. Flooded when river high. Considerable solids in inlet channel and scum on flow chamber. Difficult to pump sludge. Small plant, poor condition; unnecessarily malodorous. Sludge beds should be reconditioned.
New Britain	Fine screens (1-16-in. slots) & sand filters	Screening plant satisfactory. Filters clogged. Nuisance from stream receiving effluent. Screens clogged by oily wastes. Source of oil being investigated.
New Canaan	Septic tank and sand filters. Storm flow by chlorination only	Maintenance good. Large amount of infiltration into sewers.
Norfolk	Sand filters	Condition satisfactory in dry weather. Excessive infiltration overloads filters. Septic tank and investigation of infiltration recommended.
Ridgefield	Septic tank and sand filters	Entirely unsatisfactory. Extensive changes recommended but not carried out.
Rockville	Septic tanks and contact beds	Tanks in need of cleaning, beds practically out of commission. Sludge drying facilities needed.
Simsbury	Sand filtration	
Southington	Septic tank and sand filters	Condition good after adopting several of Bureau's recommendations. Additional filter area needed.
Stafford Springs	Septic tank	Effluent fairly clear, but discharges into air with marked odor. Recommend discharge through effluent submerged in river.
Stamford	Imhoff tanks and chlorination	Considerable odor from gas vents and withdrawn sludge. Additional labor and laboratory control desirable.
Stratford	Imhoff tanks and chlorination	Maintenance good. Plant fairly well isolated.
West Haven (main plant)	Imhoff tanks and chlorination	Much odor from gas vents and tidal basin. Practically no facilities for drying sludge. Chlorinator recently repaired.
West Haven (Prospect Beach plant)	Septic tank and chlorination	Maintenance generally good, but effluent unsatisfactory. Periodic discharge of sludge into Sound unsatisfactory.
Wethersfield	Septic tank	

Recent Legal Decisions

MATERIALMEN HELD ENTITLED TO RECOVER UNDER CONTRACTOR'S BOND FOR MATERIAL USED

A contractor agreed with a city to build a water works plant, gave bond under the Kansas statute to prevent mechanics' liens, commenced construction, ordered material, which was shipped, and then abandoned the work. The city took the material shipped, placed it in the plant and completed it. In an action by the material man, the Kansas Supreme Court held, Ludlow Valve Mfg. Co. v. Fidelity & Casualty Co., 217 Pac. 282, that the bondsmen were liable for the material so used by the city in the construction of the plant.

VILLAGE MAY INSURE ITS LIGHT AND POWER PLANT

The Ohio Supreme Court holds, Travelers' Ins. Co. of Hartford v. Village of Wadsworth, 142 N. E. 900, that the board of trustees of public affairs of a village which, under statutory authority, operates an electric light and power system, has power, within sections 4361 and 3961, Ohio General Code, to contract for an insurance policy of indemnity against liability for such operation. The power to establish, maintain and operate a municipal light and power plant, under the Ohio Constitution and statutes, is held to be a proprietary power, and in the absence of specific prohibition the city acting in a proprietary capacity may exercise its powers as would an individual or private corporation.

EXTENT OF LIABILITY OF DRAINAGE CONTRACTORS FOR DAMAGE TO LAND UNDER INDIANA STATUTE

The Indiana Supreme Court holds, State v. Jacobs, 142 N. E. 715, that the authority for the establishment of public drainage in the state rests upon the reserved power of the state to enact and enforce laws in the interest of public welfare and for the general public benefit. Such legislative action is the exercise of sovereign power, which may be delegated to local authorities, or to such other bodies, companies or corporations as the Legislature may choose to recognize and thus endow.

In an action for the use of a landowner to recover damages under a drainage contractor's bond for delay in completion, it is held that the words "damaged" and "injured" in Indiana Acts 1907, c. 252, § 5, authorizing such recovery, refer to damage to property. The section, making drainage contractors liable on their bonds for damages to land owners assessed for construction of drains by failure to complete within the time limited does not provide compensation for loss of delayed anticipated benefits by reason of the contractors's failure to complete the ditch on time. It only gives the land owner an additional remedy for the collection of his damages in case of an injury to the land itself or to growing crops or grasses, or by lessening its then productiveness, or for a reduction of its then rental value, brought about by the contractor's failure to complete within the time limited.

ESTABLISHING PUBLIC WAYS BY PRESCRIPTION

The Massachusetts Supreme Judicial Court holds, Bullukian v. Inhabitants of Town of Franklin, 142 N. E. 804, that to establish a public way by prescription, it is necessary for a town to prove an adverse use of the land, which has continued for more than twenty years under a claim of right and without the acquiescence of the owner or his predecessors in title. The mere fact of user by the public for the period required to establish a public way raises no presumption that such use is adverse. To establish such a use the further fact must be proved or admitted, that the general public used the way as a public right, and that it did must be proved by facts which distinguish the use relied on from a rightful use by those who have permissive right to travel over the private way. Where, upon the facts proved, there was nothing to show that the private way could have been closed to the public, as distinguished from invitees and licensees of the owner, without inconvenience to the owner and injury to his business, and there was no fact to prove that use of the way by the public would do any appreciable damage, and it was plain that it would be difficult to ascertain whether the person travelling on the way was doing so as a mere traveller under a claim of right, or was one who used it at the invitation or with the permission of the owner, it was held that a finding of a prescriptive right in the town was not sustained by the evidence.

REMOVAL OF BARRIER IN STREET BY THIRD PERSON CAUSING ACCIDENT, VILLAGE NOT HELD LIABLE

In an action for injuries to automobilists resulting from the removal of a culvert in a highway, where it was shown that a sufficient barrier had been erected, but that it had been removed just before the accident without the knowledge of the village authorities, the Alberta (Canada) Supreme Court held, Greenaway v. C. P. R. Co. et al., (1924) 4 D. L. R. 977, that the authorities were not guilty of negligence rendering them liable to plaintiffs.

PROVISION FOR EXTENSION OF TIME FOR COMPLETING CONTRACT

A paving contract provided that the time for completion should be extended "for such length of time as the contractor may be actually and necessarily prevented from pursuing said work by reason of injunction against him." A temporary injunction restraining the work was continued pending an appeal. It was held, Van Hafften v. Clayton, (Mo. App.) 259 S. W. 530, that the time of extension caused by the injunction did not necessarily cease the moment the opinion affirming the judgment was announced, with

no additional time whatever necessarily required for getting ready to resume work. The case was one where the contractor to resume the work must assemble a force of men and obtain materials and equipment and have them on the ground before he could resume.

MEANING OF TERM "ENGINEER'S HELP"

"Engineer's help," as used in a road improvement contract, is held to be a technical term, well understood by those accustomed to such contracts, and the parties must be held to have used the language in the light of the custom that obtained among engineers, contractors and builders, showing the meaning of such language when applied to building contracts.

A decided preponderance of the testimony of the engineers who were introduced as expert witnesses in a road improvement contract case was to the effect that it was not usual or customary for an engineer under a clause providing that; "The contractor shall furnish such reasonable amount of help as the engineer may desire in laying out and measuring the work or inspecting the material," to employ men by the month to do such work at the expense of the contractor and to deduct it from the contractor's estimates. The usual practice as to a reasonable amount of help to be furnished by the contractor to the engineer under such a clause is to send one or more laborers to make or carry stakes or hold the end of the surveyor's chain who are given or loaned to the engineer by the contractor. The contractor pays for these men and they are on his pay roll. They are loaned as a rule ordinarily for less than a day. Such a provision, it was held, did not render the contractor liable for help employed by the engineer for this purpose. Connelly V. Parkes (Ark.), 255 S. W. 22.

RECOVERY, UNDER CONTRACT, BY CITY ENGINEER OF SUMS PAYABLE BY CONTRACTORS FOR DELAY

Where a city, under a contract for the construction of water works, was required to deduct a sum for each day's delay by the contractors and to pay same to the city's engineer and inspectors superintending the work, it was held that, although the engineer could sue the contractors thereon, the city was not liable for its failure to deduct such sums.—Potter V. City of Coatesville, 297 Fed. 230.

CONTRACT RATES PAYABLE BY MUNICIPALITY FOR ELECTRIC CURRENT

The Iowa Supreme Court holds, Wapsie Power & Light Co. v. City of Tipton, 193 N. W. 643, that where a muncipality purchased a light and heating plant which had a contract for the purchase of current from another company at a very low rate, where there was no statutory authority for commission regulation of the rates, the courts could not assume that function and raise the rate payable by the city.

COMPENSATION FOR LAND TAKEN FOR PUBLIC ROAD

The West Virginia Supreme Court of Appeals holds, Lawson v. Mingo County Court, 122 S. E. 921, that where the owners without protest permit the county court, entering upon their land without permission, to construct and maintain for a period of four years a public road thereover, relying upon the agreement of the county court to pay for the land taken, they will be limited to their remedy for damages or compensation for the land, and may not by injunction restrain the further use of the roadway on the ground that the county court has failed to carry out its promise.

APPROVAL OF PLANS FOR PUBLIC BUILDINGS

The Ohio Supreme Court holds, Niehaus v. State, 144 U. E. 433, that, the General Assembly of the state having enacted a general law requiring the building inspection departments of municipalities having a regularly organized building inspection department to approve plans for the construction of public school buildings erected within such municipalities, a municipality is without power to thwart the operation of such general law by the enactment of an ordinance requiring the payment of a fee as a condition precedent to compliance therewith.

MEASURE OF DAMAGES FOR CONTRACTOR'S BREACH OF CONTRACT

The Nebraska Supreme Court holds, Horse Shoe Lake Drainage Dist. v. Fred M. Crane Co., 199 N. W. 526, that where the contractor breached his construction contract after partial performance, the measure of the other party's damages was the necessary and reasonable cost of completing the work, in excess of the original contract price, and the party recovering was entitled to interest on the same recovered from the date of the breach.

ACTION FOR SUPPLIES TO MUNICIPAL CORPORATION

The Oklahoma Supreme Court holds, Pierce Oil Corporation v. City of Woodward, 229 Pac. 181, that in an action for merchandise sold and delivered to a municipal corporation, the plaintiff makes out a prima facie case for recovery by showing the contract of sale and the delivery and acceptance of the merchandise. The burden then shifts to the municipal corporation to prove that the debt was illegally contracted or that it constituted an unlawful indebtedness in excess of the levy made by the city for the fiscal year.

JURISDICTION OVER ROADS

The West Virginia Supreme Court of Appeals holds, Chittum v. City of Morgantown, 122 S. E. 740, that by section 20, c. 43, Barnes' Code 1923, the State Road Commission cannot take over as parts of the state road system any of the streets or alleys of an incorporated city of over 2,500 inhabitants; and, until the commission has designated a particular street or alley of such city as a connecting part or link of said road system, as provided by section 101 of said general road law, the municipality is not deprived of its right and jurisdiction given by its charter and reserved by section 148 of said general road law, to make and enforce reasonable by-laws, resolutions and ordinances respecting traffic upon and over its streets and alleys.